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SANDING OF THE STREETS.

THE case of Fitzgerald *v.* Dublin United Tramway Company, which was recently heard in the Irish Court of Appeal, and which was reported in the *Irish Daily Independent* for December 20th, 1901, involved the decision of a very important point in connection with the sanding of streets by electric tramway companies. Our readers may recollect that in these columns about a year ago we published a report of a case in which the Dublin United Tramway Company were prosecuted for neglecting to put sand on the track between the rails in slippery weather. They were convicted, and on appeal the Irish Divisional Court eventually held them liable. As they were unable to carry that case to a higher Court, the case under notice is in the nature of a test action to be taken to the House of Lords. The facts were shortly these:—Suit was brought by a Mr. Fitzgerald to recover damages for injury sustained by him in a carriage accident caused, as it was alleged, by the slippery state of the track between the rails. The jury before whom the case was heard in the first instance, found that the street was in a dangerous condition from this cause, but that there was nothing wrong with the fabric of the road. They awarded the plaintiff £1,000. The defendants took the case to the Irish Court of Appeal. The case for the appellants was shortly this:— That there was no statutory duty upon them to sand or otherwise attend to *the surface* of the streets, and that therefore they were not liable; they admitted that sand was necessary to keep the road in the good condition referred to in the statute, but they said that the obligation was on the Corporation of Dublin as road authority and not on themselves. The respondent, on the other hand, contended that Section 37 of the company's private Act of 1897, imposed upon them the duty at all times, and at all seasons, to keep the surface of their line in such a state that it should not, even by atmospheric conditions, be rendered so slippery as to be a danger to ordinary traffic. After hearing lengthy arguments on either side, the Irish Court of Appeal gave judgment for the plaintiff. Lord Justice FitzGibbon, in the course of his judgment, said:—"The rights and duties of the tramway company in respect of the portion of the streets they use for their own undertaking were created by statutes which gave them a limited right to use in the streets in consideration of their maintaining them in a prescribed manner for the use of the public. So long as the company confine themselves to the exercise of that statutory right of use, and perform the statutory obligations of maintenance, they cannot become liable in an action. If they fail in that duty, and danger to the public is caused thereby, I see no reason to doubt that any individual member of the public, suffering an injury by the plaintiff's default, can recover damages . . . . It is immaterial to discuss the liability of the Corporation of Dublin in this case." Referring to the 37th Section of the Company's private Act, he said:—"I am inclined to think that the

immediate object of that section was to prevent the company having any right to use the streets in any sort of preferential way which would interfere with ordinary traffic: and that 'paving,' as expressly mentioned in that and other sections of the Act, must include the ordinary materials of the road upon which the ordinary traffic travels. It is impossible to exclude 'the surface' from 'the paving,' nor can the company be relieved from the duty of maintaining that surface in good condition and repair, so as not to be a danger to the ordinary traffic. . . . A similar duty is imposed on them by the Tramways Act, which is incorporated with their private Act. . . . Thus from the beginning and as to one and all of the Tramways Acts, it has been a condition of the user of this tramway by the defendants that they should at their own expense 'at all times' maintain the roads in good condition, paved in such a way as the road authority shall direct. That duty was deliberately left unperformed by the defendants at the time and place of the injury to the plaintiff. His right to compensation seems to me to be clear. . . . As to frost and snow causing slipperiness, I hold that the company's liability must be qualified by reasonable limitations—that is, it is not an obligation to insure against all dangers and accidents. I hold it is only their duty to take all reasonable precautions to construct the road properly. . . . In this case their offence was aggravated by disregard of the directions of the road authority. . . . In my opinion they are liable, and I think this appeal should be dismissed with costs." The other members of the Court having concurred, a stay of execution was granted on certain terms pending an appeal to the House of Lords.

The importance of this decision becomes apparent when we recollect that nearly all tramway companies, both in this country and in Ireland, are governed by provisions similar to those under discussion in this case. Before the introduction of electricity as a motive power, it was to the interest of the tramway companies to keep their part of the roadway in as good order as possible. Upon the departure of horses, it became no longer necessary to lay sand on the spaces between the rails, no matter how inclement the weather. Seeing that in many streets where tramways run, the greater part of the roadway is taken up with the track, it is obvious that this duty imposes an unfair tax upon the electric tramway companies. We are not surprised that the present case was strenuously fought, as in the course of the former proceedings, it was stated that it would cost at least £2,000 a year to provide sufficient sand for the purpose of keeping the Dublin streets in proper order.

Assuming that the decision of the Irish Court of Appeal will be upheld in the House of Lords, we anticipate that many other serious questions may arise on the construction of the section which has imposed this liability upon the Dublin United Tramways. Thus if the laying of sand is necessary for the purpose of keeping streets in good order and repair, it may be argued that sweeping, watering, and general scavenging come under the same head. This argument was naturally used by counsel for the Dublin Tramway Company; but the Chief Justice brushed it aside, with the observation that only reasonable precautions for safety need be taken by the company in endeavouring to fulfil their statutory duty. It is clear to anyone who reads the Tramway Act of 1870, that at that time no legislator ever contemplated that trams would be run through the streets without the aid of horses. The private Acts which give powers to the electric companies, contain no definition of "good order and repair;" they follow the words of the public Act without any material alteration. What is the consequence? Precautions which the companies have been taking for their own protection, have now assumed the *rôle* of a statutory duty; by an ingenious extension of the meaning of an expression in an Act of Parliament electric tramway companies must conform to, and faithfully carry out, any instructions given to them by the road authority, who may say "Unless you water your part of the roadway in the summer, we shall prosecute you for not keeping the road in proper condition." Some local authorities delight in placing a burden on the shoulders of companies who own an undertaking which they would like to work on their own account. Bitter experience has taught the "private undertaker" what fierce opposition he has to meet with on the part of the local authority in his district which is anxious to purchase his undertaking in furtherance of the "glorious" principle of municipal trading.

The recent case of Wigham, Richardson & Co. *v.* The Walker Urban District Council* afforded a useful illustration of this. In that case the plaintiff company's works occupied ground on either side of a highway running through the Council's district. For convenience, the plaintiffs had laid a tunnel under the highway, beneath which they placed certain electric cables. At the request of the Council they filled up the tunnel (the Council having complained that it was a danger to the highway), but left their mains *in situ quo ante*. The Council brought an action in the Chancery Division claiming a declaration that they were entitled to have the mains removed. At the hearing it was admitted that their object was to prevent the plaintiff company, who are probably the largest ratepayers in Walker, from using a private supply of electricity instead of that which the Council were able to furnish under their provisional order! We are glad to say that in this instance the local authority were foiled, as the Court refused to make any declaration.

So with tramway companies. The natural result of working electric tramway systems under obsolete statutes, which were drafted to meet the requirements of horse traction, has been to place undue power in the hands of the local authority. Were that power judiciously and fairly wielded, there could be no complaint; but sad experience has amply demonstrated the possibilities of "municipal blackmail."

The Breakage of Shafts at Critical Speeds.

THE paper read a few weeks ago by Messrs. Frith and Lamb before the Manchester Section of the Institution of Electrical Engineers, considered the effect of the repeated impulses of the driving power upon a shaft when such impulses happen to coincide with the period of oscillation of the shaft itself. Considering a shaft as a torsion member fixed at one end and carrying a double ballistic pendulum to represent the fly-wheel or generator, it is evident that if the pendulum be deflected through a given angle producing torsion in the shaft, it will, when released, be carried by the elasticity of

* The ELECTRICAL REVIEW, November 8th and 15th, 1901.

the shaft nearly as far in the direction opposite to the original stress, and will so oscillate back and forth many times before coming finally to rest. This, say the authors, in effect, is practically the condition of an engine shaft which is put under stress and torsion by each steam impulse. The crank is pushed a small angle ahead of the fly-wheel. The elasticity of the shaft recovers this small angle and reverses it, so that when next the steam pressure comes on the piston there is a cumulative effect, and the torsion angle is greater at each successive impulse until finally the shaft breaks. This, it is, argued will be the result when the period of oscillation of a shaft coincides with the frequency of the steam impulses. Obviously when there is not synchronism, the shaft torsion is only that proper to one impulse. There is no cumulation of effort. Such being the case, if a shaft were found to be in danger, it could be rendered safe by one of the following means :—

(*a*) Its length exposed to torsion could be changed so as to alter the period of oscillation.

(*b*) Its diameter could be altered, preferably by way of increase, so as to change the period of oscillation.

(*c*) The engine speed could be changed so as to destroy the synchronism.

(*d*) The fly-wheel or direct-coupled generator could be changed to alter the period of the "pendulum."

It appears to us that in the case of engines with more than one crank, the division of the crank angle unevenly would have the surest effect in killing the effects anticipated. It is quite possible there may be something in the idea, but it is probable that even then the calculation of the synchronism is hardly possible for lack of data, though perhaps there might be an experimental determination of the period of oscillation for every case. A word of warning might not be misplaced. The practical engineer who has had engines to run, will not relish an addition to the fine-drawn theories that are flung at him to account for the breakage of a too obviously weak crankshaft. Crankshafts of direct-coupled sets have failed so often, and so notoriously, from weakness, that a scientific explanation will be quite welcome to those who too persistently adhere to old-fashioned methods or views of stresses, and decline to accept Wöhler. We would rather advocate a study of reversed stress action before undertaking the new thory of periodic synchronism.

The Duff Gas Producer.—The Duff gas producer was shown at Glasgow Exhibition supplying gas to the Stirling boiler. This producer has a central inclined grate of Λ form, the air and steam to feed it coming in under the grate. At each side there is a free opening to a water bottom, which forms a seal and a clinkering pit. The whole producer measures 12 ft. diameter × 11 ft. 6 in. high. It is fed with fuel through two hoppers; these are on the top, and the gas is drawn off near the top at the side. The fuel hoppers have bells and slide doors. The clear space inside the brick lining measures 7½ ft. × 9 ft. The total grate area is 40 sq. ft., and the capacity of the producer is 15 cwt. of slack per hour. The central grate is a good idea, because it safeguards against the common fault of excess of air escaping directly upward to the outlet. From the producer the gas is led off to the boiler, and enters a transverse flue below the back of what would usually be the grate surface. It escapes from this flue by a series of slots into a mixing chamber, 3 ft. × 2 ft. 5 in., where it is mixed with air from another flue. There is a small grate for coal, sometimes used in conjunction with the gas. The mixed air and gas combined in a clear flame, and the results are stated to have been good. Gas firing ought to be done with heated air, and the water-tube boiler should prove more efficient than a plain shell boiler for abstracting the heat from a colourless flame. No information is available as to whether the tubes of the boiler suffer from any deposit of soot and dirt. At sea this is the usual great trouble with water-tubes, and it has been proposed to add scrapers, as in Green's economiser. In the Babcock marine boiler cleaning is done by means of a pipe 1½ in. diameter, with nipples spaced between each row of tubes. The pipe moves through a range of 120° on its axis, and the cleaning is claimed to be efficient. There is a peculiar deposit in all boilers using bituminous coal, which is too gummy to be removed, either by scrapers or by a steam jet. Probably producer gas, well made, and free from hydro-carbons, will not produce such a deposit.

THREE-PHASE DISTRIBUTION FOR POWER AND LIGHTING.

By SYDNEY WOODFIELD.

WITH the present knowledge of three-phase working, it appears strange that its merits for lighting and power distribution are so little known in this country, as for transmission and conversion into either low tension alternating or continuous currents it presents no difficulties whatsoever, but on the other hand, affords a complete solution of the problem of supplying lighting, and within fairly wide limits, power also, for central and outlying districts.

Three-phase systems are now being largely put down on the Continent and in America for power and lighting, while in this country high frequency single-phase systems are still put down; such systems are fatal to the commercial success of the undertaking, and in time must be replaced by the polyphase system.

Generators can now be built for 10,000 volts or more in machines of moderate sizes, with a cost of only 6 or 7 per cent. more than for machines of half that voltage, the extra cost covering the additional insulation required. A 10,000-volt machine is just as reliable as a 5,000-volt one, as the same factor of safety is allowed in both cases.

In using the higher voltage, however, the cost of cables becomes heavy, for, according to the Board of Trade regulations, the insulation thickness for a 10,000-volt cable must not be less than ½ in. between any conductors, or between conductors and the lead (the B.O.T., however, sanctioned ¼ in. for the Glasgow tramway cables, working at a pressure of 6,500 volts), and as practically all high tension cables are insulated with impregnated paper, and so require to be lead covered, it will be seen that the lead itself will cost no inconsiderable amount; adding to this, the large size of ducts required, and the extra cost of laying, the total sum will be a pretty substantial amount.

It is doubtful whether the Board of Trade would allow any method of laying other than the solid system for this potential, and the author estimates the cost of a 0·1 sq. in. three-core stranded paper cable, including laying, excavating, troughing, &c., at about 20s. per yard.

It is unnecessary to enter into the relative merits of the various frequencies to be used, as each has its own particular sphere, but for lighting and power distribution a frequency of 40 cycles per second may be taken as a good all round standard.

The advantage of the three-phase system for distribution for lighting and power work lies in the fact that it can be economically used for transmission over considerable distances, and thus a central station can do a large amount of business by supplying power to the outlying factories and mills, and in the supply of small lighting plants in the outlying districts. Another advantage lies in the fact that rotary converters can be operated, and direct current for tramways or light railways can be produced, or direct current may be required for lifts, hoists, &c., or for electrolytic work. The disadvantage of the two-phase system, as compared with the three-phase, taking first the two-phase three-wire system, is that for a definite amount of power to be transmitted at a definite pressure with a given loss, the amount of copper is considerably in excess of that required for the three-phase system under the same conditions, and, moreover, the system on inductive load is very difficult, if not practically impossible, to operate.

The two-phase four-wire system possesses similar disadvantages to the two-phase three-wire as regards copper, but for lighting solely is fairly satisfactory, while on inductive load the operation is difficult. It will be seen that such a system must be divided into groups or sets of groups, this division naturally overcoming many advantages, and, moreover, it becomes necessary to control each group by means of an induction regulator, as the load factor of the various groups may be entirely different owing to the peculiarities of the different neighbourhoods into which the groups run, consequently, to keep constant pressure adjustment on each group requires careful attention.

With a two-phase generator both groups are of course influenced by the same field, although, as stated above, they

are subject to entirely independent variations. In the discussion set forth below it must not be forgotten that a three-phase generator is capable of taking 75 per cent. of its rated capacity on one phase with normal heating, and this single-phase load is to all intents and purposes as great as that which could be carried by a machine of equal weight and cost, if it had been specially designed for single-phase work. It might possibly be suggested that the above reduction of output would be sufficient reason for using a balanced two or three-phase system; a little consideration, however, will show that this is not the case, since the cost of direct coupled generators of the same frequency is practically dependent on the speed. Thus a 500-KW. alternator of slow speed costs very little more than a 400-KW. alternator, the difference certainly being less than half the proportionate difference of the ratings.

If the generator is connected "star" fashion, and is used as a single-phase machine, two-thirds of the windings are active, and the placing of these active coils is practically the same as would be arranged for, assuming the machine to be designed for single-phase working. In the first system of three-phase distribution for power and lighting the generators are connected "star" fashion, with a fourth wire

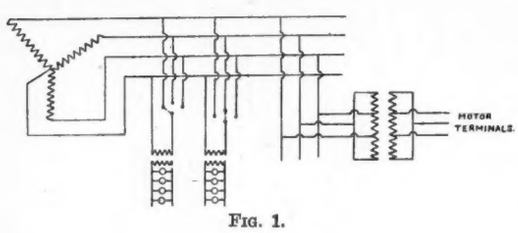


FIG. 1.

taken from the neutral point; this system is used by the Chicago Edison Company for the outlying districts of Chicago, and also at Cincinnati, Toledo, &c.

In the Chicago system the potential between line wires is 4,000 volts, and between any line wire and neutral about 2,300 volts. From the station three-phase feeders are run, each capable of supplying 500 KW. or more, these long feeders delivering power to areas, say, of a couple of miles in radius; through each of these districts a three-phase 4,000-volt network is carried, suchwise that all consumers may be connected by short single-phase branches tapped off from one outside wire and the neutral. The necessary transformation is done by means of an ordinary transformer wound for 2,300 volts primary and the declared voltage on the secondary; this transformer either supplies an individual customer or a small

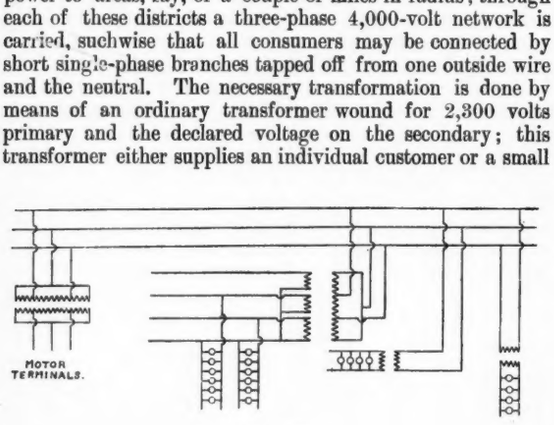


FIG. 2.

local three-wire secondary network, the various branches being arranged to give a balance as near as possible. When motors are required to be operated, they may be run from the three-phase mains, "delta" connected transformers preferably being used, or, perhaps, better still, a three-phase transformer, as this would be a very good balancer. It would be advisable (in fact, the Board of Trade require it) to earth the neutral wire in order that no potential difference other than that for which it is designed should be thrown on the transformer. This system, which is shown in fig. 1, is so connected together that motors can be operated with practically no effect on the lighting.

The Commonwealth Company, of Chicago, have arranged their feeders so that they can be switched on to either of the three outside wires and the neutral, and any feeder can, if desired, be independently regulated.

Another system which may prove advantageous in certain cases is the four-wire low tension three-phase system, as shown in fig. 2.

In this case the primaries of the transformers are connected "delta" fashion, while the secondaries are connected "star" fashion, the neutral being carried to the common connection, and the lights being connected between one of the outside wires and the neutral wire; these are balanced as nearly as possible, while motors are connected to "delta" connected transformers across the three line wires.

It will be found that for the same lamp voltage, this system is more economical than the three-wire direct current system. If lighting is required outside the four-wire low-tension network, this can be done by running single-phase feeders (as shown on the right of fig. 2) from one side of the three-phase mains, these various branches being balanced as nearly as possible. It will be found, however, to be better practice to run out large three-phase mains with single-phase branches, these branches being made as short as possible, so that the loss in each is cut down to a minimum. When the system is laid out on the above lines, motors can be operated with little or no effect on the lights, since a single motor would only be a very small part of the load taking current from the network from which it is operated. The above system is in operation at Salt Lake City, Utah.

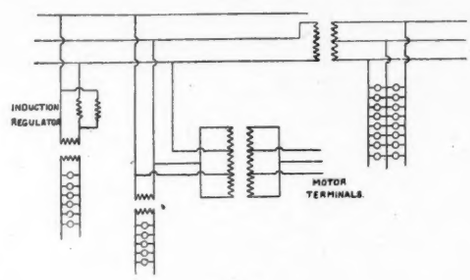


FIG. 3.

A third system (fig. 3) is that of low-tension distribution by the single-phase three-wire system in the central districts of a town or city taken from one side of a three-phase generator, the generator potential being adjusted only as regards the three-wire network, and the remaining two phases being used to operate lighting outside the low-tension three-wire network, these feeders being regulated by means of potential regulators, either operated by hand or automatically.

A third wire may be run into these outside districts if there be any demand for power for motors. In this system no regard is paid to balancing the load on the generators, except that the outside lighting is divided approximately between the two phases, which are not used for the three-wire single-phase low-tension network.

The voltage of the outside feeders can always be shown by a suitable compensating voltmeter.

In most towns or cities the greatest load is situated in the central district, and can thus be run from an inter-connected single-phase low-tension system, the regulation being adjusted to give the best results for this district; thus the most important part is the best regulated.

As all motors, whether of the asynchronous or synchronous type, and rotary converters will take their load from the least-used phase, since this phase has the highest potential difference, they will consequently diminish the unbalancing of the generators; they will also disturb the potential of the lighting phase less than it otherwise would be disturbed, if the motors took a large part of their power from that phase. In certain cases, as, for instance, where a single-phase system already exists, the two-phase system may be suggested as the only way of using the cables already laid, more especially if these be of the concentric type (concentric cables are out of the question for satisfactory results with three-phase working), but the author would suggest that the excellent results obtained from the three-phase system for power and lighting over considerable areas, and the disadvantages accruing from the two-phase system, would make a careful study of the whole problem necessary, and it will

be found that even in the event of having to pull out several miles of concentric cable, the balance will lie with the three-phase system.

As much has been said regarding the use of induction potential regulators, it may not be out of place to give a brief description of this useful piece of apparatus.

An induction regulator is very similar to an induction motor, the primary winding being placed on the movable core, whilst the secondary is placed on the stationary core; the primary is connected in shunt across the mains, whilst the secondary is in series with the mains. The potential in each phase of the secondary winding is constant, but, by varying the relative positions of the primary and secondary, the effective voltage of any phase of the secondary can be varied from maximum boosting to zero, and so on to maximum lowering. The coils are former-wound, and insulated in a similar manner to the coils of induction motors. The method of operating is either by hand or by a motor; in the first case, the movable core is rotated by means of a hand-wheel, but when the regulator has to be operated from a distance, a small motor is arranged for driving the core through a suitable gearing.

The motor can be either a polyphase or continuous current one, and is controlled by a small double-pole, double-throw switch, thus throwing the switch in one direction lowers the voltage, and *vice versâ*. In order, however, to stop the motor on reaching the limits of regulation when moving in either direction, a limiting switch is provided, which opens the switch automatically. The efficiency of these regulators is somewhat higher than that of an induction motor of the same capacity, but as they have no moving parts to create a draught, they cannot, except in small sizes, be made self-cooling; for the larger sizes they are made for oil or air-blast cooling, depending on which is most convenient for the work on which they are being used.

ELECTRICAL PROGRESS AND LEGISLATION: THE NEED OF REVISION.

[COMMUNICATED.]

THE paper on the above subject, read by Mr. R. Percy Sellon at the London Chamber of Commerce on the 18th ult., is a carefully compiled and useful *résumé* of the difficulties under which the industry has laboured, through the statutory conditions by which it has been controlled.

The growth of the socialistic principle in our municipalities, which Mr. Sellon points out as a result of "the failure of legislation relating to water, gas, and similar undertakings, to provide for adequate control in the public interest," has become so threatening to the very existence of all private enterprise, that the most strenuous efforts are necessary to check and control it.

Mr. Sellon refers to the effect of this principle upon the construction of the Tramways Act, 1870, and the Electric Lighting Act of 1882, and emphasises the contention that it is in the control over applications for provisional orders, by requiring the consent of the local authorities, that much of the mischief to the industry has arisen.

It is true that the Board of Trade can dispense with the consent, if satisfied that it is improperly withheld; but the difficulty is in persuading the department that a sufficient reason exists for the exercise of their discretionary power.

As you have previously pointed out, numerous cases have occurred in which consents have been refused because the municipality own the gas supply, and in many other cases in order to give time to the local authority to decide whether they will apply for powers themselves—in all these instances accomplishing the one object of preventing any supply being given for years.

The principle upon which the consent should be dispensed with is well illustrated in Sub-section 4 of Clause 54 in the Cleveland and Durham County Electric Power Act, 1901, which enacts that:—"If any question arises as to whether the consent of any authorised distributor is unreasonably withheld, that question shall be determined by the Board of Trade, and the consent shall be deemed to be unreasonably withheld if the authorised distributors are not willing and in a position to give the requisite supply upon reasonable terms and within a reasonable time, and in considering what are reasonable terms and what is a reasonable time, the Board of Trade shall, amongst other things, have regard to the terms upon which and the time within which the company are willing and in a position to give the supply."

This form of instruction to the Board of Trade, having been incorporated in an Act of Parliament, might well be accepted and adopted by them as a guide in dealing with the practical working of Clause 1 of the Electric Lighting Act, 1888. If this were done, the dog in the manger would soon be disposed of, and one great obstruction to the legitimate development of the industry removed.

There is common sense underlying the definition of what is an unreasonable objection in the clause taken from the Cleveland Act, for it recognises the right of the community to be supplied by those who prove their readiness to undertake the business at once.

Mr. Sellon mentions the fact that no less than two-thirds of the 366 provisional orders granted to local authorities at the end of 1900 are still in abeyance. This is really a public scandal, and could be remedied at once by the order being revoked automatically upon the expiration of the period stipulated for the supply of the compulsory area.

You have dealt with the question of consent only as it affects applications for provisional orders by companies, but it is of more importance that no such powers should be granted to local authorities until the sanction of the ratepayers has been given to the proposed speculation. If this were done (and there is no reason why the same principle should not be applied to provisional orders as to the promotion of Acts of Parliament) very few schemes would be sanctioned.

We have seen the result of an appeal to the owners and ratepayers in the poll recently taken on the promotion of the Omnibus Bill of the Birmingham Corporation. The proposed Bill included tramway schemes, supply of electricity outside the area of the city, powers to accept transfers of provisional orders—all in the nature of municipal trading, besides the more legitimate matters connected with municipal management. The result of the poll was a vote against the promotion of about 8 to 1. Another instance occurred in the North Metropolitan district last February, when the joint promotion of a Bill by the Urban Councils of Enfield, Tottenham, Edmonton, Wood Green and Southgate for supplying all those districts with electricity was defeated on a poll by large majorities. The informal, but carefully-taken poll of the ratepayers of Tonbridge in connection with the Local Government inquiry in May last, resulted in a vote against the Council's speculation by about 9 to 1, and although the Local Government, in granting the loan, ignored the opinion of the ratepayers, it was an additional proof of the opposition to the proposed municipal trading when the question is fully discussed and understood.

What is required, then, is an active propaganda for the purpose of educating the ratepayers throughout the country. An association of the trading industry generally should be formed on the widest basis, with branches in every town. All trades are menaced, those in which the municipalities are already engaged include, as Mr. Sellon points out, not merely the provision of water, which is closely linked with sanitation, but the business of gas supply, tramways, electricity, bakeries, banking, building, coal merchants, colliery owning, fire insurance, hotels, games, kursaals, refreshment rooms, theatres, manufacture and sale of electric fittings, of residual products of gas, milk supply, pawnbrokering, printing, steamboats, tailoring, telephones, &c., a tolerably long stride towards the goal of universal municipal trading and the abolition of private enterprise.

The opening remarks of Lord Avebury at the London Chamber of Commerce meeting were conclusive as to the baneful influence of Government interference with private enterprise, the position of the railway service under State control in India, which he contrasted with that in the United States, the Argentine, and China, where private enterprise drew a large amount of British capital, and proving the enormous advantage to the community of leaving all such business in the hands of the commercial trading classes.

THE FACTORY AND WORKSHOP ACT, 1901.

The passing of the Factory Act, 1901, which came into force on January 1st, 1902, is, from an industrial point of view, the most important event of the recent session. The outcome of a long-standing promise made by the present Government, it certainly cannot be said to have been redeemed too soon, for a Bill of a similar kind has been laid on the table of the House of Commons every year for several years past. In view of its importance generally to every industry, and of the fact that electric lighting and power stations are now for the first time specifically referred to as coming within the definition of the word "factory," we propose to give an outline of its object and of some of its more important provisions.

The Act consists of 165 sections, which are made up of all the old Factory Acts (1878—1895), together with a number of important amendments, which were discussed in the early part of the session of 1901 as an "Amendment Bill," and were subsequently incorporated with a Consolidation Bill. It would be impossible, therefore, for anyone who has not followed the Act in all its stages, or who has not an intimate knowledge of factory law, to make out, by looking at the text as it now stands, what parts are new and what are old. In addition to this certain alterations of minor importance were made in the drafting office without the express sanction of Parliament, and the language of the older Acts is in many instances so much altered that they cannot be easily recognised.

To begin with, the chief alterations in the law may be said to be:—(1) The introduction of new regulations giving the Home Secretary power to make orders with regard to dangerous trades; (2) the prohibition of employment of children under 12 in any factory or workshop; (3) the provision of means of ventilation and the drainage of damp floors; and (4) the shifting of much of the responsibility for the proper execution of factory law from the shoulders of the factory inspectors on to those of the local authorities.

In the following outline we propose to draw special attention to those portions of the Act (*a*) which are *new*—that is to say, which did not appear in any of the previous Factory Acts; (*b*) which affect industries connected with the supply of electricity and electrical apparatus.

The Act is divided into ten parts, which are as follows:—Part I.: Health and Safety; including (1) Health; (2) Safety; and (3) Accidents. Part II.: Employment; including (1) Hours and Holidays; (2) Special Exceptions as to Hours and Holidays; Overtime; Nightwork; Intermittent Employment; Supplemental; (3) Fitness for Employment. Part III.: Education of Children. Part IV.: Dangerous and Unhealthy Industries, including (1) Special Provisions; (2) Regulations for Dangerous Trades. Part V.: Special Modifications and Extensions Relating to (1) Tenement Factories; (2) Cotton Cloth and other Humid Factories; (3) Bakehouses; (4) Laundries; (5) Docks; (6) Buildings; (7) Railways. Part VI.: Home Work. Part. VII.: Particulars of Work and Wages. Part VIII.: Administration, including (1) Inspection; (2) Certifying Surgeons; (3) Local Authorities; (4) Special Orders; (5) Notices, Registers, and Returns; (6) Miscellaneous Provisions. Part IX.: Legal Proceedings. Part X.: Supplementary, dealing with (1) Application and Definitions; (2) Application of Act to Scotland and Ireland; (3) Repeals, &c.

That part of the Act which deals with "Health and Safety," contains all the similar provisions of the older Acts, with certain important amendments and additions. In cases where the Secretary of State is of opinion that the provisions of the Act, or of the law relating to public health, in so far as it affects factories, workshops, and workplaces, have not been carried out by any District Council, he may, by order, authorise an inspector of factories to take, during such period as may be mentioned in the order, such steps as appear necessary or proper for enforcing those provisions (Sec. 4 (1)). By the same section, plenary powers are conferred upon inspectors to do such things as the local authority may have left undone.

New and important provisions are introduced with regard to temperature and ventilation in factories. Thus it is provided by Sec. 6 that adequate measures must be taken for securing and maintaining a reasonable temperature in each room in which any person is employed, but the measures so taken must not interfere with the purity of the air of any room in which any person is employed. Ventilation has also received the attention of the Legislature. Hitherto, occupiers of factories have only been compelled to provide ventilation by mechanical means in places where grinding, &c., are carried on in such a manner as to cause the generation of dust to an injurious extent. In future, by Sec. 7 of the new Act, sufficient means of ventilation shall be provided and sufficient ventilation shall be maintained in every room in any factory or workshop. The Secretary of State is to prescribe the standard of ventilation.

In the case of a manufacture which renders the floor liable to wet, adequate means must be adopted for draining off superfluous water.

With regard to provisions for the safety of persons employed in factories, steam boilers are now for the first time brought within the category of "dangerous machines." By Sec. 11 (1) every steam boiler used for generating steam in a factory or workshop, or in any place to which any provisions of the Act apply, must have a proper safety valve and proper steam and water gauges, and must be inspected at stated intervals by a "competent person." This provision will relate to boilers used in electrical works, which are now included in the term factory.

The jurisdiction of justices to make orders with regard to the use of dangerous machines (including boilers) is slightly enlarged by the new Act. Thus by Sec. 17 a Court of summary jurisdiction, on being satisfied that any part of the "ways, works, machinery or plant" used in a factory, &c., is dangerous to life or limb, may prohibit its use either entirely, or until it is altered or repaired. This power formerly extended to machinery *simpliciter*.

With regard to accidents, those portions of the older statutes which provided for notice of accidents, and inquiries into the cause thereof, are reproduced in Sub-secs. 19—22 of the new Act.

Omitting certain changes in hours and periods of employment, which are dealt with in Sub-secs. 23—60 of the Act, the next important innovations are contained in Sub-secs. 61 and 64 under the heading "Fitness for Employment." By Sec. 62 it it provided that a child under the age of *12* must not be employed in a factory or workshop unless lawfully so employed at the commencement of the Act. The age limit was 13 under the older Acts. With regard to certificates of fitness, certifying surgeons are now empowered to qualify certificates issued by them with conditions as to the kind of work on which a child or young person may be properly employed. In past years the surgeon's power was limited to the mere issue of a certificate [see Sec. 64 (6)].

Secs. 79—86 contain the new provisions relating to the power of the Home Secretary to make regulations for dangerous trades. As these are new in their entirety, it would be superfluous to deal with them in these columns. One important point is worthy of notice, however, and that is, when an inquiry is instituted to consider whether any and what regulations shall be made in any particular trade, masters and men will have a *locus standi* to be heard before the court of inquiry. Regulations made by the Home Secretary under these sections must lie on the table of both Houses for 40 days after they have been passed. During that period their validity may be called in question, and they may, if necessary, be annulled. It is unlikely that generating stations, or any factory where electrical apparatus is manufactured, will be subjected to regulations of this kind.

The Act is to a certain extent limited in its application to particular industries. Thus a dock is not a factory for all the purposes of the Act. It is provided, however, by Sec. 104 that the provisions of the Act with respect to (1) power to make orders as to dangerous machines; (2) accidents; (3) regulations for dangerous trades; (4) powers of inspectors; and (5) fines in case of death or injury, are to have effect as if every dock, wharf, quay and warehouse, and all machinery or plant used in the process of loading or unloading or coaling any ship in any dock, harbour and canal were included in the word "factory." It will be seen

that this greatly enlarges the definition of factory as used in Sec. 23 of the Factory Act of 1895, with the result that the scope of the Workmen's Compensation Act, 1897, which applies to all factories as defined by the Factory and Workshop Acts, is considerably extended.

By Sec. 106, railway sidings, not being part of a railway within the meaning of the Railway Employment (Prevention of Accidents) Act, 1900, are brought within those provisions of the Act which, as above pointed out, are applicable to docks.

By Sec. 110, salutary rules are made to prevent the occupier of a factory giving out wearing apparel for repairs in any home, in which the inmates are suffering from any infectious disease.

By Sec. 144, a person engaged in, *or being an officer of any association of persons engaged in* the same trade or occupation as a person charged with any offence under the Act, must not act as a Justice of the Peace in hearing and determining a charge. The words in italics are new.

Such are the more important *new* provisions in the body of the Act; but Schedule VI. contains, in parag. (20) thereof, a provision of very material interest to electrical engineers and manufacturers, and the occupiers of generating stations. It provides that in the list of non-textile factories to which the Act is to apply there shall be included "electrical stations"—that is to say, "any premises, or that part of any premises, in which electrical energy is generated or transformed for the purpose of supply by way of trade, or for the lighting of any street, public place, or public building, or of any hotel, or of any railway, mine, or other industrial undertaking." Up to the passing of this Act there was considerable doubt whether a generating station was a factory within the meaning of the Acts. We recall one case in which it was argued that a generating station was a factory in which an "article" was manufactured, and that it therefore came within the Acts! As a general rule, we believe that occupiers of such institutions have admitted the factory inspector, and have conformed to his requirements. Under the new Act this will be compulsory, not optional.

Mr. Evans Austin, in the new edition of his work on "The Law Relating to Factories and Workshops,"* thus summarises the effect of the new provision of Schedule VI.:—"This is new. Any premises or the part of any premises in which electricity is generated for supply by way of trade, or current in bulk, or for lighting streets, public places, or buildings, hotels, railways, mines, or 'other industrial undertakings,' will now be a non-textile factory. Premises which are used in a private capacity, such as a club or society, even though electricity may be generated therein, will not, however, become non-textile factories."

It will doubtless take some time for the new Act to be put into working order. To judge from the number of cases which have recently been heard in the Courts under the older Acts, it is possible that the Act of 1901 may also form the subject of frequent discussions in the King's Bench, for in the making of amendments very little (if any) effect seems to have been given to the cases which have turned upon the meaning of doubtful words and phrases. Whatever may be the result of the Act as regards litigation, it has at least the merit of consolidating a number of conflicting statutes which were amended and re-amended *ad infinitum*. The reduction of chaos to order is a work of which the present Home Secretary may well be proud.

ELECTRIC CAR EQUIPMENTS AND THEIR MAINTENANCE.

BY A TRAMWAY ENGINEER.

SUCH is the title of a welcome paper read by Mr. Wigram before the Newcastle Local Section of the I.E.E. It was a paper eminently suited for discussion, and we hope that it received its full meed. Most of the important points are touched, but the subject is of such magnitude that the paper would have been inordinately long if full attention had been given to every detail.

The author thinks that single truck double-deck cars are the best for urban service, till the passenger density has become too great with the minimum headway; and that for interurban work the double truck car is indispensable. Later on he points out that the overhang of single truck cars is very great, and that the cars are knocked about at points. To our mind the racking that these rigid cars have to endure, and the absurd overhang, together with their uneasy riding over inferior track, are quite enough to make us pray for the day when the last of them will have made way for the stately, smooth-paced, double-bogie.

We were delighted beyond measure to read that, "speaking generally, the writer has a strong objection to maximum traction trucks." In time past the REVIEW has chronicled its antipathy to this same monster. "The objections which apply to all types of maximum traction trucks are the slipping of the driving wheels, and the difficulty of proper adjustment of the brakes. . . . One generally sees one, or even two pairs of wheels picked up when a car is making a sudden stop." Just so. We have lately seen the newest type of maximum traction truck, by a well known firm, and have no hesitation in saying that it looked absolutely impracticable. To add to the confusion of springs, levers, equalising rods, and unsymmetrical frame, slipper brakes were added; and it seemed to us that if many of those trucks were used the wages sheet would require considerable enlargement.

We are in agreement with Mr. Wigram in his choice of the best short truck. For ease of riding and strong simplicity we have found nothing to beat the "Brill" truck. We have not tried the new "Brush" truck, but hope, for the sake of its British make, that it will put its American fore-runner into the shade. There is one point about the Brill truck which needs attention. It has a curious lateral motion when going fast, which reduces the life of the wheels very considerably.

On the question of brakes, the author condemns air brakes for urban service, desires slipper-brakes on grades steeper than 1 in 12 or 15, and insists on an emergency brake. From recent utterances it would appear that there are still some people who do not appreciate the fact that an electric emergency brake is generally obtained by the short circuiting of each motor on itself, the motors for the nonce becoming dynamos driven by the moving car.

Mr. Wigram will not hear a word in favour of the rheostatic brake, but we think he condemns it too easily. It *is* difficult to make motormen handle anything properly; but if the rheostatic brake is used with care in conjunction with another brake it is distinctly serviceable, and not too expensive. He inclines to the side of the electro-magnetic friction brake, which does not call upon the motors so heavily. The fact is, that most of the motors in British cars are American, and are rated within an ace of their lives; so that it does seem cruel to call on them to retard as well as to accelerate.

Mr. Wigram quotes a test which he made, showing that when the emergency brake was applied with the car going at 2 miles per hour, a current of 80 amperes flowed.

He prefers the intermittent-flow sand valve to the continuous-flow type. Our preference is for the latter, as being more reliable and easier for the motorman. He expresses a desire to have the sanding pedal change its usual position with the gong pedal, but we do not think the rearrangement would carry any advantages. It is possible to place the sand pedal so that it can be actuated by the heel, while the toe is clicking the brake pawl. For sudden braking, it is usual to sand with the right foot, and to lock the brake with the left.

Life-guards are being patented every day, many of them being provided with an advance gate, or trigger, which folds back and releases the life-guard when struck by a body. There is no doubt that a life-guard is essential. It appeases the coroner somewhat.

To return to the beginning of the paper for a moment, the author does not consider the reversed staircase an improvement. It may not be ideal for loading and unloading passengers quickly, but it obviates any possibility of a passenger being thrown off the car by a sudden jerk; it utilises every available inch of the top deck, and, above all, it affords considerable shelter to the motorman and conductor. We do not understand why single-ended cars are never used.

* (1902) at p. 266.

All that is required is a loop, or triangle, at the termini, and that should not be a fatal objection in most cases. You have then one staircase only, one controller, and half the number of cables under the car. The motorman can be housed in a compartment half the size of an ordinary platform, and you obtain from four to six more seats than with a double-ended car of any type.

The idea of fixing real air extractors, instead of the ordinary clerestory windows, and of leaving some of them without cut-off grids, so that some ventilation is compulsory, is an excellent one. A car full of people who wash every Saturday is neither pleasant to enter, nor to dwell upon.

It is mentioned that dash plates are made sometimes of $\frac{3}{8}$-in boiler plate, which protects to some extent the controller in a collision. The best way to protect the controller is to attach it so lightly to the platform that, when the dash is knocked in, the controller simply goes with it without breaking the frame. At the same time a few inches of slack should be left in the cables entering from below.

From conversations with manufacturers of trolley wheels, we understand that every engineer has his own opinion as to the shape and size of wheels. Mr. Wigram is no exception, but his reasons for choosing his particular type are not sufficiently convincing. He proportions wheels so that wheel and bush wear out together. Except on a side-running system, this would mean a very heavy wheel ($2\frac{1}{2}$ to $3\frac{1}{2}$ lbs.). Some people prefer to lighten the wheel, and use the bush twice. We have never been much impressed with the several types of self-oiling hollow spindles on the market, trusting rather to the nightly oil can, as being less expensive in the long run.

If Mr. Wigram thinks, as he says, that the two principal types of swivel trolley head leave little to be desired, he has been singularly fortunate in his experience.

For double-deck cars, the enclosed spring trolley standard is most widely used. That standard is the most desirable which best fulfils these conditions :— Constant pressure at trolley wheel for varying heights of wire; easy swivelling and vertical motions; waterproofness; easy adjustment of tension; absence of internal insulators; checks for extreme movements, either up or down.

It is difficult to understand why the author prefers to use the parallel notches of the controller rather than the series notches, when one motor has been cut out. It is the old Walker method against the General Electric, and the latter is generally favoured, as the whole of the resistance is used in starting, instead of only the parallel portion.

The practice mentioned of using multicore cables instead of a bunch of cables in a canvas hose is one which will spread.

The last part of the paper is devoted to "Maintenance." It is treated rather scantily, and is too large a subject to tackle in the short space at our disposal.

THE SIZE AND WEIGHT OF SPHERES.

By ROLLO APPLEYARD.

In an article entitled "A Note on Wires," which appeared in the Electrical Review of March 1st, 1901, the writer described a simple method for calculating the change in weight of a wire, corresponding to a definite small change of diameter. It is there shown that for any given material a constant can be found, which, when multiplied by the number representing the diameter of a given wire in mils., expresses the change in weight of unit length of the wire in pounds. It is satisfactory to observe that this "mil-constant" is being utilised by manufacturers as a ready means of determining the error in weight of wires, produced by an error in the die, or by the stretch, in the process of drawing or covering it. Conversely, it enables cable makers, from the actual weight of a trial length, to calculate by simple division the corresponding number of mils. to be added or deducted from the next run of work, in order to attain accuracy of weight.

The application of the same principle in the manufacture of spheres is a simple piece of arithmetic; so simple, in fact, that the writer would hesitate to put it on record here were it not that he has found it a valuable aid, especially in the design of dies and other tools intended to produce spheres of given gauge and weight. The "mil-constant" in this case is a number which when multiplied by the square of the diameter of the sphere, expressed in convenient units, gives the weight corresponding to the addition or substraction of a 1 mil. spherical shell of given material of that diameter.

As a familiar example we may suppose that the diameter is expressed in mils., and the weight in dwts. The weight, p, in dwts. of any sphere of diameter d mils., and density Δ is

$$p = 5{\cdot}5179\ d^3\ \Delta \times 10^{-9}.$$

To find the "mil-constant" we could plot a curve co-ordinating p and d, and proceed as described in "A Note on Wires" (*l.c.*), but the result can be arrived at more quickly by differentiating the above expression, whence we obtain

$$\frac{d\,p}{d\,d} = 1{\cdot}65537\ d^2\ \Delta \times 10^{-8}.$$

This means that for any ball whatever, of diameter d mils. and density Δ, one mil. more or less in the diameter will make a difference in the weight of the sphere of $0{\cdot}0000000165537\ d^2\ \Delta$, the weight being in dwts. Thus for steel balls, using mils. and dwts., where $\Delta = 7{\cdot}8$, the mil-constant is $1{\cdot}291 \times 10^{-7}$; for spherical lead bullets, where $\Delta = 11{\cdot}3$, the mil-constant is $1{\cdot}871 \times 10^{-7}$; for ivory billiard balls, where $\Delta = 1{\cdot}917$, the mil-constant is $3{\cdot}173 \times 10^{-8}$; and for golf balls, where $\Delta = 0{\cdot}935$, the mil-constant is $1{\cdot}548 \times 10^{-8}$. These numbers are to be multiplied by the *square* of the given diameter.

To exemplify the use of this mil-constant, we can determine the differences in diameter corresponding to the favourite sizes of golf balls. The paint on a golf ball weighs about 0·5 dwt., and there are further differences due to variations in the markings, but these for our purpose can be disregarded. Assuming $\Delta = 0{\cdot}935$, the diameter of a "$27\frac{1}{2}$" (*i.e.*, 27·5 dwts.) golf ball calculates out to 1,747 mils. Making use of the above mil-constant, the weight in dwts. of 1 mil. more or less on such a ball is

$$1{\cdot}548 \times 10^{-8} \times 1{,}747^2 = 0{\cdot}0472 \text{ dwts.}$$

It follows that an extra $\frac{1}{2}$ dwt. makes a difference in diameter of 10·6 mils., or about one-hundredth of an inch. The player who can distinguish between the sizes of a "27" and a "$27\frac{1}{2}$" golf ball, may therefore congratulate himself upon possessing very fine perception of the relative dimensions of bodies.

THE TESTING AND MANAGEMENT OF ELECTRIC MOTORS.

By P. T. WHITE, Wigan Electricity Works.

(*Continued from Vol.* 49, *page* 1069.)

Brake methods of testing for efficiency, however serviceable they may have been in the old days before the design and calibration of electrical measuring instruments reached their present excellent standard, can scarcely be recommended. They are undoubtedly cumbersome, and require a certain amount of skill in order to get approximately correct results. I have never seen this method applied to the testing of electric motors, but I have painful recollections of some steam engine tests in which it figured prominently. Heedless of the fact that three different indicators, successively employed, gave precisely the same figures, the brake worked on its own, and gave, often for the same loads, different results. I have, however, an open mind on this matter of brakes, and am open to persuasion.

Referring to efficiency tests for motors, I give the following formula as useful :—

$$\frac{d_{\text{E}} \times d_{\text{C}} \times 100}{m_{\text{E}} \times m_{\text{C}}} = \text{per cent. efficiency of combined set.}$$

In the equation d = dynamo quantities and m = motor quantities.

To those—and my experience teaches me there are many—who cannot grasp the full significance of an equation, the following simple rule is given :—

Multiply the watts on dynamo side of combination by 100, and divide the result by the watts taken by motor to get the combined efficiency.

The methods of testing for faults and insulation will be discussed later. Records should be kept of all tests—in particular the efficiency tests. These will be found of great value to the assistant in charge of the department, and will enable him to employ for particular loads motors having a comparatively high efficiency.

With reference to motor management, I shall confine my remarks to the practice that usually obtains in central station work. At the outset, I regret to say that, except in a few large and well-managed stations, this department does not receive the attention its importance demands. It either gets into the hands of a man of no previous experience, and little mechanical training, or, what is still worse, it falls a prey to a number of self-assertive satraps, in whose hands it sooner or later collapses like a house of cards. The fact that little or no effort is put forth to attract the power user, the constantly recurring breakdowns, the irregular service attendant on improperly designed systems, and the glaring inexperience written large on every detail of the plant arrangement, account for the small demand for electric power in many places where a field for considerable development exists. It is only when one comes to the consideration of the *personnel* of these motor departments that one begins to realise why it is that the designer of dynamo-electric machinery is a man of mystery and gloom.

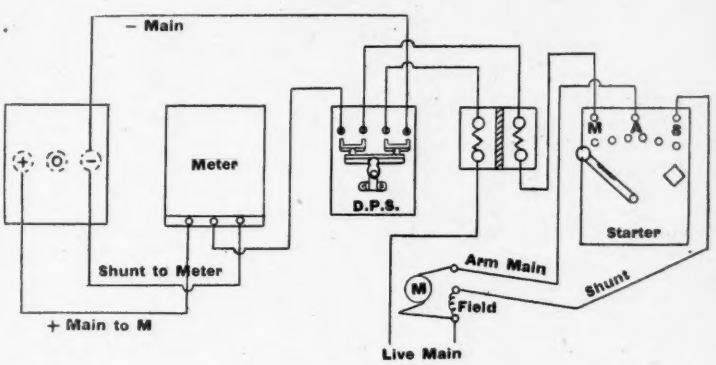
It will, I believe, be wholly unnecessary for me to say that, where possible, compound-wound generators should be employed in preference to simple shunt machines. The exigencies of nearly all "combined" stations prevent this, because of the usual practice of employing the compounding for traction purposes. Where the number of motors supplied by an outer and the neutral is large, steam balancing becomes a necessity. It is far more flexible, and in reality can be made as automatic as any electric balancer system. It is also far more reliable. In either system the battery will be in parallel for "cushioning" purposes wherever motor power is supplied from shunt-wound generators, as it is well known that these machines are peculiarly sensitive to the vagaries of a network, their E.M.F. falling and rising with any decrease or increase of resistance in the external circuit.

Starting at the beginning, it will not be out of place if we consider the motor connections. It will be found advantageous to have "a rule of the road" in these. If the D.P. switch is placed "before" the fusible cut-outs, the operation of inserting a fuse can be carried out without risk of shock. Again, if it be determined that certain terminals of the D.P. switch—say, those furthest apart—shall be the "live" terminals direct from the service boxes, it will tend to simplicity in testing and repairing operations, and if consistently followed no one need for a moment remain in doubt as to what metal on a board is alive or not.

It may not perhaps be out of order if I digress for a moment to give a few suggestions to those whose knowledge of and experience in this kind of work is limited. The diagram shows the connections for a motor with meter in circuit.

It is in some places a usual practice to employ a red or otherwise marked cable for the purpose of distinguishing the "live" main to motor; while this is very commendable, it is nevertheless a good plan to test for the field in the following manner, as errors of connection are likely to result in damage to the motor, inconvenience to consumers, and injustice to manufacturing engineers.

Remove the "armature" cable, either at the starter or motor, keeping same from contact either with "earth" or motor case. Next close the D.P. main switch and move the starter lever to the first live contact. If the connections are right the motor field will be established, and when the lever is released a flash will result, due to the breaking of the shunt circuit. Then connect up the armature cable, oil the bearings, and see that all cables, connections, &c., *inside* the motor case are clear of revolving parts. The motor can then be started up in the usual manner. Should the motor run the reverse way, the simplest way to remedy this is to stop and change over the shunt connections. There is another way to effect this, but until considerable experience in the running of motors, and a sound knowledge of the technical principles on which they work have been gained, it will be as well not to employ it in the case of compound motors. It is this: make the "armature" connection on the motor the "live" connection, and the "live" connection the "armature." Reversing the main leads alone will not be attended with any effect, so far as the control of the direction of rotation of the motor is concerned. It will be well also if the following useful hints are carefully borne in mind:—



A line has been accidentally omitted from the figure, above the words "Live Main."—Eds. Elec. Rev.

Diagram of Connections of Motor and Accessories.

1. That the "lead" (for increasing loads) is, contrary to that of a dynamo, backward against the direction of rotation.

2. That a backward lead is attended with demagnetisation of the motor field.

3. That any decrease of the field excitation will cause the motor to run faster.

4. That giving a backward lead to the brushes should always be accomplished with discretion, especially with machines taking a heavy current.

5. That should sparkless commutation ensue as the result of a backward lead with load "on," try what will result by opening the main switch before finally screwing down the brush rocker.

6. That the starter is *not* by any means intended to be a shunt breaker.

7. That the efficiency of a motor falls as its load increases, and that for this reason it will be found economical to employ machines "well on top of their loads."

8. That a drum-wound armature will continue its work even when there is a dislocation in its circuit, or even with a "burnt-out" coil.

9. That, unlike a dynamo, the brushes of a motor can be raised even when the motor is doing its work. "Making a switch of the commutator" should only be resorted to in cases of emergency. Once the brushes are raised, and the motor perceptibly slackens its speed, they should be kept up until the starter lever flies back to the "off" position, thus putting in the necessary resistance in the armature circuit for the next start.

10. That a loose or broken armature connection, or a burnt-out coil on a drum, will be evidenced at the commutator by a "flash over" spark and marked commutator bars.

11. That the insulating bushes for the brush spindles are by no means mechanically strong.

12. That though a simple shunt machine is to a large extent self-regulating, it is not so much so as a differentially compounded one. (*To be continued.*)

THE TRANSFORMATION OF THE UNDERGROUND RAILWAY.

I.

Now that the award in the arbitration case between the Metropolitan and District Railways is generally known, it may not be out of place to put before our readers a retrospective view of the situation which led to the attitude taken up by the Board of Trade when the two companies failed to arrive at a mutual understanding as to the method of electrical working which should be adopted on their respective lines.

The arbitrator's report is what most thinking people had anticipated, and the comments of a jaundiced contemporary suggesting that the whole inquiry was a solemn farce with a verdict agreed upon beforehand between the parties, is a grave slur upon the Hon. Alfred Lyttleton and his coadjutors, and on the proverbial impartiality and fairness of an English tribunal. The decision of the Board of Trade was published in the REVIEW for December 20th, and we will at once hark back to April 9th, 1900, when Sir J. Wolfe Barry and Sir William H. Preece issued their first report on the experimental trials of an electrical train between Earl's Court and High Street, Kensington.

The experiments and tests referred to in this report had been carried out two or three months previously under a contract made between the companies and Messrs. Siemens Brothers, dated November, 1898. The section of line between the above-named stations was particularly well adapted for such experiments, as it comprised almost every obstacle and difficulty likely to be met with in the introduction of a new system of traction on any portion of the system of the two companies concerned.

Some there are who have not hesitated to characterise the expenditure of some £30,000 on these experiments as a wicked waste of the shareholders' money, as no such trials were required, except for the purpose of giving the consulting engineers some practical knowledge of electric traction. Others have stated that the demonstrations were necessary to convince the directors and shareholders of the two companies that electric traction was not a myth. With this, however, we do not intend to concern ourselves, so our remarks will be confined to the tests and the results deduced therefrom.

The distance between the stations is a few yards in excess of three-quarters of a mile, and the experimental train, which we described and illustrated in our issue of May 25th, 1900, was made up of six vehicles (a motor in each end carriage, with four intermediate coaches), and the weight was, when empty, about 180 tons, made up as follows:—

Two bogie motor coaches of 54 tons each.

Four 40-ft. bogie coaches of 18 tons each.

The leading motor coach was the only one used, the trailing motor coach running idle.

The weight of the electrical train was some 40 tons in excess of the ordinary Circle trains, due to providing a motor coach at each end so as to avoid shunting after every trip at one or the other station. In everyday working one motor coach would be dispensed with and its place taken by two or three ordinary carriages, giving total seating capacity at least equal to that of the present Circle trains.

The Metropolitan and District locomotives have only a weight of 36 tons on the driving wheels available for adhesion, as compared with the full weight (54 tons) of the motor carriages, the whole of which could be utilised.

The tests carried out comprised a series of automatically recorded observations on "tractive force," "acceleration," &c.

The average time occupied by the electrical train of 180 tons from Earl's Court to High Street was 2 minutes 24 seconds; that of the ordinary District Railway trains 2 minutes 37 seconds with a train weight, including locomotive and passengers, varying from 115 to 150 tons.

The quickest record for the electrical train was 2 minutes 8 seconds, giving a mean speed of 21 miles an hour, the maximum rate attained on ordinary journeys being 30 miles.

On February 8th, 1900, a "tug-of-war" contest took place between the electromotor and a Metropolitan District locomotive. The steam locomotive was attached to the electrical train, and both started to push against each other at the same moment.

The steam engine was completely at the mercy of the electromotor, which easily pushed it back, although handicapped by the weight of the experimental train, which had not been uncoupled.

Other tests of a more severe character were carried out, but invariably in favour of electrical power.

Three days later a load of 40 tons, equal to 800 passengers, was distributed through the train, which was brought to a stand on an ascending grade of 1 in 43. A District Railway locomotive was coupled on in front, and several attempts were made to start the train, without success. Then the electromotor came to the rescue, and hauled both train and locomotive, weighing altogether 267 tons, up the incline with ease.

The power exerted on that occasion is stated to be equivalent to that necessary to start a train of 1,200 tons on the level. The maximum rate of acceleration of the electrical train was as high as an increment of 0·966 per second for each second observed.

Taken as a whole, the engineers considered the experiments proved that electric traction could be successfully introduced as a motive power on the companies' lines, either with or without the present system of steam, and that there was no need of either interference with existing conditions or any interruption of traffic. The companies' rolling stock might also be utilised without material alteration, and heavier trains could be operated at higher speeds than is now the case.

The engineers specially pointed out that the "multiple unit" system had not been lost sight of, and that this could, if desirable, be afterwards gradually introduced as necessity arose, but they considered the advisability of adopting in the first instance a system which would permit of the utilisation of the existing coaches to be of paramount importance, and outweighing any possible advantages of the "multiple unit" method.

The trials also fully demonstrated that electric locomotives could be substituted for steam, or *vice versâ*, for working trains such as other companies might require to be hauled by steam for a portion of their journey outside the system of the two companies which might afterwards be electrically equipped.

A second, but apparently undated, report was made some months afterwards, probably towards the end of August, when the train had been in continuous daily working from May 14th to August 14th. It was in operation for eight hours a day, its mileage, including shunting, was 30 miles per diem, and the daily trips in each direction 14, the total distance traversed being 1,750 miles.

Coal and water consumption are also given, but there is no need to reproduce the figures here, as the engineers found it difficult to make any comparison between them and those of a steam locomotive performing similar duties. Not only was the power developed by the electromotors very largely in excess of the power of an ordinary steam locomotive, but the conditions of the service, averaging three or four short journeys per hour, made it impossible to form a comparison either on the basis of mileage or time. The total mileage of the experimental train from November 9th, the date of the first trip, was 2,250 miles, and the working throughout was unattended by any delay or inconvenience to traffic or maintenance. No expenditure incurred on repairs to motors or on the plant in the generating station.

During the three months of daily working the average time occupied on the journey from Earl's Court to High Street was 2 minutes 20 seconds, the fastest being 2 minutes, and the acceleration recorded was equivalent to a rate increasing 1·28 ft. per second, a most satisfactory result.

Then followed a remarkable report from Mr. Thomas Parker, of Wolverhampton, which, however, we must leave for another issue; but we may say here, in conclusion, that it was in direct opposition to the opinions of Sir J. Wolfe Barry and Sir William H. Preece.

Electric Lamp Manufacture in Mexico.—The first works for the manufacture of electric lamps in Mexico are about to be started.

ENGLISH, AMERICAN AND CONTINENTAL STEAM ENGINEERING.

THE second article by Mr. P. Dawson in the *Engineering Magazine* describes a number of power stations in brief, and illustrates some English and American engines, notably those at Glasgow. As the Musgrave and Allis engines at Glasgow are now getting fully to work, an opportunity of gauging their merits will soon be offered. There is considerable difference between the two engines.

The American engine has bored guides, an unnecessary arrangement for an engine intended to run one way only. The English engine has slipper guides. The American engine seems to have been designed with a preconceived idea of the impossibility of correctly aligning the crankshaft, which is divided into sections with two crank pins loose in one web. The Musgrave crankshaft is rigid, with a central bolted coupling, but with no provision for bad alignment. The standards vary considerably, those of the English engines being plain box rectangular, and wide spread, while the American bases are of the narrow conical circular type, so usual in quite small engines. The valve gear of both engines appears to be unnecessarily complicated, being of the Corliss release type. Americans seem to forget that the principal advantage of the Corliss valve, viz., cylinder drainage, half disappears when the valve is applied to a vertical engine.

In Mr. Dawson's article, the Liverpool station at Pumpfields is also described. In this station we find that, for a 1,200-H.P. engine, no fewer than nine cylinders appear to have been considered necessary, and they are arranged on three cranks.

Mr. Dawson's description of the Hull tramway engines gives a hint at a piece of faulty design, namely, a bearing between the fly-wheel and the generator. This arrangement is English, and though not so bad as the practice of putting fly-wheel and generator at opposite ends of the crankshaft, is quite bad enough.

We cannot subscribe to Mr. Dawson's views as to the onerous nature of the work of a traction station engine. Polyphase currents, we admit, do demand exceptional design, but ordinary direct-current tramway work does not produce the stresses imagined. These imaginary stresses served the purpose of selling many American "specially" strong "traction" engines, which are now seen to be specially strong only in comparison with previous American work, and by no means special as compared with English practice. The idea of special stresses ignores the fact that the maximum stress in an engine is that due to the steam pressure, and that, given proper fly-wheel location, the engine stresses cannot exceed what the design provides, or should provide, to be borne. Varying load matters nothing to the engine, which does not measure its behaviour on one stroke by anything that happened on the previous stroke. As an example of better design, we may cite the Musgrave engines of the Bolton tramway described by Mr. Dawson, a plain pair of vertical cross-compound condensing engines, with fly-wheel and generator placed between, as they should be.

A list of some of the principal American engines supplied in this country is given. It is by no means a complete list. The author appears, however, to be of opinion that its future growth will not be rapid, because of the growing carelessness of Americans, who certainly appear to act in many ways as though they considered anything good enough for the foreigner. Mr. Dawson states that times of delivery of English engines are now better than they were, and such being the case, the only reason for ordering abroad has disappeared, for English prices are lower than American, and English qualities are certainly better, especially in durability.

Other stations described are those of Dublin, the Central London, and the Isle of Thanet, but in these, as in former descriptions, there is no information as to the cars driven, the presence of accumulators, the ratio of mean to maximum load, or anything to enable an estimate of performance to be arrived at. The article concludes with a brief description of the steam turbine, that coming motor which will demolish the difficulties of oil in boilers and solve the incrustation problem. We are promised Continental practice in the next paper.

THE DISASTER ON THE LIVERPOOL OVERHEAD RAILWAY.

A FIRE, which resulted in the loss of six lives and much damage to the Dingle Station and rolling stock of the Liverpool Overhead Electric Railway, took place on Monday evening last week. Shortly before six o'clock a train consisting of three carriages entered the Herculaneum Tunnel, which forms the terminal length of the railway at the south end of Liverpool. The tunnel is 800 yards long, and has a diameter of 25 ft. 6 in. At the south end of it Dingle Station, the terminus of the railway, is situated. An inclined subway lying between the station on the low level and the booking hall on the road level, gives access to the station from the road above, and serves as the exit from the station. On Monday evening a train entered the tunnel shortly before six o'clock, and had nearly reached the end, when the passengers were alarmed by a vivid flash, followed by an outburst of flame from the rear end of the car. A motor had fused, and the woodwork beneath the car had ignited. This mishap, occurring at the extreme rear of the train, caused the disaster. A strong wind was blowing into the mouth of the tunnel, and this fanned the flame and blew it along the underside of the carriages. The passengers immediately attempted to escape, and all appear to have got out of the burning carriages on to the footway of the tunnel. They, however, very naturally, fled before the fire, retreating into the station, the end of which, with the exception of the entrance to the subway, formed a kind of *cul de sac*, which soon became full of suffocating smoke. A reserve stock of creosoted sleepers by the side of the railway took fire and burned furiously. The platform and other woodwork of the station also caught fire, and the conflagration became general. Meantime, most of the passengers had found the subway, and escaped to the booking hall on the higher level. Here, for a time, their progress was barred by a closed door. This was eventually battered down from the outside, and the imprisoned passengers escaped through the door or through the windows of the booking hall. Meantime, however, all of them had been nearly suffocated, as the full volume of smoke from the fire was blown into the confined part of the station below, and then up the subway, by which they were making their escape. Six persons, including the guard and driver of the train, unhappily lost their lives, succumbing, it is believed, under the dense and suffocating fumes which filled the tunnel. The foreman at the station, Thomas Randalls, was also among the victims of the catastrophe. In response to a telephone message sent by Randalls shortly after the outbreak of the fire, the current was cut off from the section. This also took the current from the electric lighting system, so that station and subway were deprived of all light, save such as came from the burning train and the woodwork of the station, thus greatly increasing the terror of the passengers.

Mr. S. B. Cottrell, general manager of the railway, was speedily on the spot, and the city fire brigade were promptly in attendance. The fire had, however, got a firm hold of everything combustible within reach, and practically burnt itself out. The woodwork of the train and the platform of the station was completely destroyed. Mr. Cottrell explains the disaster as being caused by the fusing of a motor, an occurrence which in itself would ordinarily have been of no moment. The position of the train when the mishap occurred, near the end of the long tunnel and in the strong air blast which was driving into the mouth of the tunnel from the north, favoured the ignition of the woodwork after the fusing of the motor, and caused the flames to spread rapidly and with so destructive and fatal results.

In working, the trains on the Liverpool Overhead Railway take up current from an insulated conductor laid midway between the rails. The conductor was laid in 32 ft. lengths, and connected with copper fishplates with flexible joints every 96 ft. Current is obtained from the generating station at Bramley Moore Dock. The armatures of the motors are series wound on the Eickmeyer system, and are built directly on the axles. The tractive force of each motor at rim of wheel, with 120 amperes, is 1,790 lbs., equal to about 107 lbs. per ton of train.

The Board of Trade inquiry into the accident took place at the offices of the railway company, at Liverpool, on Friday last. Colonel Yorke, R.E., who was assisted by Mr. A. P. Trotter, represented the Board of Trade. Before taking evidence, Colonel Yorke and Mr. Trotter, accompanied by Mr. S. B. Cottrell, manager of the railway, and Mr. J. W. Alsop, solicitor to the company, visited the Dingle Station and inspected the scene of the disaster.

On returning to the office of the company, William Owen, signalman in the employ of the company, was called. He deposed to seeing the train enter the Dingle tunnel and to its being pulled up about 80 yards from the platform. He noticed that something was wrong. The driver (Ashbee) switched on to re-start the train, and when he did so there was a big glare at the back end of the train. Maloney, the guard, called out to Ashbee: "You will burn us out if you go on like that!" Maloney came to the front of the train and asked Ashbee why he did not try one motor. Ashbee replied that he knew his work. The fire started in the end coach. Maloney shouted to witness to telephone to the generating station to have the current cut off. The current was cut off. The witness gave further evidence as to the progress of the fire and the steps taken to extinguish it, and as to the efforts of the passengers to escape from the burning train and the station. Questioned by Colonel Yorke as to what he had seen when the train stopped, witness said that each time Ashbee switched on to re-start the rear of the train fired. He had never seen anything like it before on the Overhead Railway. The operation of switching brought both motors into use.

George Gough, a train booker, gave evidence as to assisting passengers to escape, and as to the progress of the fire and the efforts made to extinguish it. (This is the brave youth of 16 years, who was so highly complimented by Colonel Yorke.)

William Shuttleworth, booking clerk, stated that he received a telephone message from the foreman Rendall asking him to ring up the generating station to have the current cut off. Witness gave evidence as to the lighting arrangements and the means of egress from the tunnel, and of the ticket collecting arrangements.

Traffic-Inspector Lenthall gave evidence as to the progress of the fire and of assisting to extinguish it.

Richard Orford, foreman at the Herculaneum Dock Station, said that the train was six minutes late. He noticed that the insulation of the train was smelling, but it smelt very often when a train was a bit late. He supposed it was caused by the overheating of the resistance coil or something of that sort. Maloney said: "She's humming, isn't she?" That meant smelling. It was a bye-word. It was not a frequent occurrence.

Charles Cunliffe, foreman driver, in reply to Colonel Yorke, said that he had not had any complaints to make of the train on previous occasions. It had only come out of the sheds that morning, after being overhauled.

In reply to Mr. Cottrell, witness said the train only went into the shed for the ordinary overhauling, and to have the brakes adjusted.

George Jackson, coach lifter, gave evidence as to the condition of the train after overhauling. He adjusted the brake blocks, and put the machine in working order.

Colonel Yorke remarked that he supposed that a little "humming" would not be regarded as a very serious fault?

The Witness: No.

Alfred Ingham, motor and carriage superintendent, gave the history of the train since it was built and delivered to the company in 1894. With regard to the motors, witness said that the armatures and field magnets at the south end were rewound in 1897. Since then the train had run 26,911 [? 126,911] miles. As regards the north end, the armature was rewound in February, 1896, and the field magnets in September, 1899. The mileage run since the armature was rewound, was 142,551 miles approximately.

Mr. Trotter asked witness whether, in a case of fusing out, he had ever known a case where it had spread to any part of the carriage?

Witness thought there was a case about two years ago, but he was away on holidays.

In reply to Col. Yorke: He had never known a case of a burning armature setting fire to part of the train. He had not had any complaints about the motor at the rear of the train.

Mr. S. B. Cottrell, engineer and general manager to the company, in reply to Mr. Trotter, said the automatic circuit-breakers were set to go at 160 amperes. They frequently went. One might go half a dozen times in a journey. When the driver switched in, the circuit-breaker would go. The motors were nine years old. If they were renewing, they would adopt the ironclad motor. It was a more up-to-date motor.

Asked if they had ever had any serious fire in a driver's cab, witness replied "Never."

Witness gave further evidence as to the provisions made for protecting the stations of the company from fire.

By Mr. Alsop: There was no reason why the train should have been stopped at the Herculaneum Station. On a damp day it was quite common for the insulating material to get damp and for heat to be generated. The material would then smell as an ordinary dynamo would.

By Colonel Yorke: The reason the flames spread so rapidly was because the wind was blowing a hurricane up the tunnel. On an ordinary day he did not think the fire would have spread at all.

At the close of the inquiry, Colonel Yorke and Mr. Trotter visited the company's carriage works and inspected the motor, from which the carriage had been removed.

A coroner's inquest into the circumstances attending the death of the six persons who lost their lives by the burning of the train at the Dingle station of the Liverpool Overhead Railway, was opened at Liverpool, before Mr. T. E. Sampson, city coroner, on Friday. Certain evidence having been taken, the inquiry was adjourned until January 8th.

LEGAL.

Chamberlain & Hookham *v.* The Corporation of Bradford.

In the Court of Appeal, composed of Lords Justices Vaughan-Williams, Romer, and Cozens-Hardy, on 20th ult., a considered judgment was delivered in this case on the appeal of the plaintiffs from the judgment of Mr. Justice Farwell in the Chancery Division, dismissing the plaintiffs' action to restrain the alleged infringement by the defendants of the plaintiffs' patent (No. 4,225, of 1887), for improvements in electricity meters. The defendants denied the alleged infringement, and asserted that the plaintiffs' patent was invalid on various grounds. Mr. Justice Farwell, while expressing no opinion as to the validity of the plaintiffs' patent, held that the plaintiffs had failed to show any infringement of the patent. Hence the present appeal of the plaintiffs. The arguments on the appeal concluded on November 29th, when judgment was reserved.

Lord Justice Romer read the judgment of the Court, which was to the following effect:—This case has been argued by the learned counsel on behalf of the plaintiffs at great length, and with much detail. The effect of their discussion of minute points arising in the case, coupled with the many difficulties involved in their elaborate consideration of electrical and magnetic laws, has been, in our opinion, somewhat to obscure an otherwise fairly simple and intelligible case. We think that when the pith and substance of the questions involved in this appeal are sought for, they can be readily understood, and be shortly stated and determined, and we propose in this judgment to avoid all details that are not necessary to be mentioned, having regard to the grounds of our decision, and to briefly state what the merits of the case, in our view, are, and why we think that the appeal fails. In the first place, it is important to consider how matters stood with reference to the subject of the plaintiffs' invention immediately prior to the patent in question. The principle on which the plaintiffs' electricity meter, and also the defendants' meter, were subsequently constructed, was then well known. It had been pointed out that such meters might be made by means of a motor and a brake worked and used in the manner subsequently adopted in substance in the plaintiffs' meter and in that of the defendants. In particular, Mr. Siemens published his design of an electrical meter in which he employed the motor with a brake effected by wings revolving in a fluid—with reference to this design, it was pointed out by Marcel Deprez that it was wrong in principle to use the last-mentioned kind of brake, inasmuch as the resistance varied, or tended to vary, as the square of the velocity, whereas it ought to vary directly as the velocity. In other words, he stated with reference to these meters what has been called the straight line law, and he recommended the employment as a brake of a disc rotating between the poles of a permanent magnet—that is to say, the brake subsequently employed in defendants' meter, and the use of which in reference to the plaintiffs' machine was referred to by the patentee (Mr. Hookham) in his specification. But to make such a meter as was thus made known to the public, a good practical machine up to commercial requirements, a difficulty had to be overcome—the difficulty of friction. Mr. Hookham surmounted the difficulty chiefly by the use of a special commutator, a very ingenious contrivance; and this was, in our opinion, the most important part of his invention. Now so far as the commutator is concerned, the defendants' machine in no wise employed the same means of overcoming the difficulty as those adapted by Mr. Hookham. The defendants' machine, indeed, proceeded far more than the plantiffs' did, on the lines of Mr. Siemens's machine as corrected by Marcel Deprez. In the defendants' meter Mr. Siemens's commutator was used, with a very ingenious modification. So far, then, as the commutator is concerned, and, indeed, so far as the machines generally are concerned, apart from the question as to permanent magnets used by the defendants, which we are about to mention, the two machines are, in our opinion, substantially different, though both are based on what was published and known prior to the date of the plaintiffs' patent. It appears to us, therefore, that the plaintiffs must fail in this action unless they can establish that the defendants have infringed the patent by reason of the use of the permanent magnets employed by the defendants on their brake. Now the plaintiffs contend that they have claimed by Mr. Hookham's specification, and are entitled under their patent, to the sole right to the use for the purpose of electricity meters, in connection with either motor or brake, of any permanent magnet having large polar surfaces closely fronting each other, so as to form a narrow slit in which the armature or disc revolves. But it appears to us, for reasons we are about to state, that the plaintiffs fail in this contention, and that the claim (Claim 3) in their specification did not extend to cover the use of every permanent magnet having large polar surfaces, with a narrow slit between them, but was limited to what has been called a compound or built-up magnet—that is to say, to an arrangement of bar magnets or of other equivalent magnets (though differing in shape and configuration from bar magnets), with pole-pieces having surfaces of the above-mentioned kind. And this being so, what the defendants are doing is not within the plaintiffs' claim. Now, in the first place, we may point out that it would be very difficult for the plaintiffs to say that their Claim 3 was a valid claim, if that claim was so extensive as to cover what the defendants are doing with their brake, for the defendants are using the knowledge given to the world by Marcel Deprez. They are taking his brake for the purpose indicated by him. He pointed out that it should be made by a disc revolving in the field of a permanent magnet. Now, the magnet used by the defendants is not of a form or shape unknown at the date of the plaintiffs' patent. On the contrary, the evidence is that the defendants' magnet is of a common kind. Nor, indeed, do the plaintiffs say that a magnet like the defendants' was unknown at the date of the patent. What they say is that Mr. Hookham discovered that certain shaped magnets, covering a large number of well-known magnets (including the defendants') were peculiarly well suited, by reason of their possessing constancy and power, for use in connection with brakes. But it is not easy to understand how this discovery could entitle the discoverer to prevent persons from using known magnets for the purpose of Marcel Deprez's known brake. But it is not necessary for us to decide whether Claim 3 would have been valid if it had been more extensive in its operation than, in our opinion, it is. It is sufficient for us to say that the patentee may well have shrunk, in making his claim, from risking its validity by making it broader than it is. We will now turn to the body of the specification. That deals with the use of permanent magnets as an alternative in the place of electro-magnets, which the patentee fully describes. No drawing is given of any permanent magnet. We have, therefore, to depend entirely upon what is said in the specification in order to ascertain what the patentee is claiming in respect of permanent magnets. The first mention of permanent magnets is at page 4, line 39, where he refers to their use in reference to the removal of bars from such magnets for the purpose there indicated. Then comes the important description (at page 5, line 2, and following). The patentee there speaks of "a number of bar magnets being substituted for the electro-magnet represented in the drawings, though I may use magnets of other shape or configuration," and he adds that in all cases he wants the pole-pieces of a certain shape. This appears to us to point to an arrangement for magnets with certain pole-pieces. If the patentee had really intended to claim the use of every magnet having pole pieces with large surfaces and small slit, he ought to have made that clear. But he has not done so. And, indeed, his object being to make permanent magnets "very powerful and very constant," if he had thought that he had effected his object solely by the form of the pole-pieces, we should have expected him to state this, and also to inform the public within what limits as to size of the surfaces of the pole-pieces and distance apart the pieces should be in order to be effective in power and constancy. But he has not done so. He has said he "prefers" a certain ratio to be

observed, but he only gives that ratio by reference to a minimum, and the evidence shows that his ratio would cover a large number of magnets well known at the date of his patent. If he was not describing his pole-pieces as an adjunct to his arrangement of magnets, but was contemplating a claim apart from that arrangement, he was in a position of considerable difficulty, having regard to public knowledge at the time of his patent in reference to the use of permanent magnets with a disc to form a magnetic brake in electricity meters. For in this case he would not be claiming the use of some new combination or arrangement of magnets, or of some new magnet invented by him, but would be claiming the use of every known magnet which happened to have poles with what he calls "large" surfaces, and which formed between them what he calls a "narrow slit," merely because he had discovered that they possess valuable qualities with reference to a use which might well be held known. It appears to us that it would not be fair as against him to hold that he intended to make such a large claim, which might have made it invalid unless he had clearly indicated such an intention. And if as against him we should not have held such an intention shown, we ought not to hold it now in his favour, because it suits his present purpose to seek to cover what the defendants are doing. But we think that an examination of the wording of Claim 3 itself strongly confirms our view that his claim was not so large as he now contends it is. He only in terms claims the use of permanent magnets, "arranged as described with" (which we think means "accompanied by") "very large polar surfaces," &c., and the claim is further covered by the last words, "substantially as herein described and in part illustrated by the accompanying drawings." So far as the drawings are concerned with magnets, they show and describe only an electro-magnet, and the description in the body of the specification of his permanent magnets is (as above mentioned) with reference to a number of bar magnets being substituted for the electro-magnet represented in the drawings, though, as he says, "I may use magnets of other shape and configuration." Whether in any case the patentee's description of his magnet is sufficiently clear to support a claim for it we need not consider, having regard to the conclusion we have come to that his claim, at any rate, does not extend to cover the defendants' magnet as used on their brake. For these reasons it appears to us that the defendants' machine is no infringement of the patent, and it is unnecessary for us to consider the other points taken on behalf of the defendants, some of which were dealt with by Mr. Justice Farwell in his judgment. The appeal must be dismissed with costs.

CORRESPONDENCE.

The Crawford-Voelker Lamp Tests.

Your issue of December 20th contained some criticisms on the Crawford-Voelker electric incandescent lamp by a writer who does not claim to have ever seen the invention. He criticises Colonel Holden's report because it does not specify that he tested high voltage lamps, although the context will show that such must have been the case, because he says, "As regards Crawford-Voelker lamps of lower voltages—100 volts for instance—there is no difficulty whatever in their manufacture. . . ."

Since writing that report Colonel Holden has informed me that he has made a successful test with 400-volt lamps.

I thank you for your kindly paragraph which follows the criticism of an unknown person of a lamp wholly unknown to him. Without discussing his motives, I consider that you yourself fully answered him. As to further official tests, I consider that having regard to the exhaustive tests made against me by Colonel Holden during a period of nearly a year, and in consideration of his high standing, any further tests would be in the nature of a criticism on Colonel Holden and his work rather than a test of the lamp.

I beg leave to add that Colonel Holden is now testing lamps in his laboratory on his own account every day, and that the 400-volt and the 500-volt lamps, which can be made by no one except in our laboratory, represent in reality, in my opinion, the electric lamps of the future.

One of the essential and important features of this invention, so far as high voltage lamps are concerned, relates to the form of the lamp. The 400-volt carbon filament lamp could not be pumped in the ordinary bulb without such an enormous loss by the arcing across as to make it commercially impossible.

T. C. Crawford.

[We regret that we must differ from Mr. Crawford as regards the completeness of the replies to our correspondent, "F. J. G." It has unfortunately come to our knowledge, by more channels than one, that the lamps tested by Colonel Holden were *not* of 8 C.P. each, but of higher denominations. We are reluctantly obliged, therefore, to concur with "F. J. G.," as to the impropriety of comparing the results obtained in the tests referred to, with those obtained with 8-C.P. lamps; such a comparison is wholly valueless, and worse—it is misleading. Under the circumstances we feel it to be our duty to press our proposal to carry out independent and impartial tests of the Crawford-Voelker lamps, at our own cost; and if our offer is not accepted, our readers, as well as ourselves, will draw their own conclusions.

Our feeling in this matter is intensified by statements which have been made to us to the effect that a prospectus is in course of circulation, dealing with the Crawford-Voelker lamp; we cannot too strongly impress upon our readers the necessity of ascertaining the truth about this invention before they part with a penny of their money.—EDS. ELEC. REV.]

From a Man at the Front.

During the last few days strong rumours have been going round of a reinforcing draft of E.E. coming out; we are all looking forward to their arrival, or, better still, the advent of two relieving companies; not that we are "fed up," but a change would be very acceptable.

The Electrical Engineers, R.E., are doing a very large amount of work for a small body of men, and every man is fully employed; we find great difficulty in filling the places of men going sick, but fortunately we have been very free from sickness, although the men are spread all over the country.

We all feel very proud of Sergeant Entwistle, Corporal Holliday, and 2nd Corporal Rook, who have been awarded the Distinguished Conduct Medal for services in South Africa; Corporal Holliday is still serving with us.

Wishing you a happy and prosperous New Year,

E.E., R.E.

South Africa, *December 5th*, 1901.

The Testing and Management of Electric Motors.

Re the above interesting article in the REVIEW of 27th inst., I should like to ask Mr. White, through your columns, how even "so-called tests" could be carried out without an ammeter in circuit, and what was the object of such?

I should also like to ask where Mr. White himself was when this "careless and foolish man" went away to seek for resin? Later on in his article, Mr. White states that "meters, for instance, which, in some stations, are never properly tested, can be included in the circuit." Although I agree with Mr. White that the testing of meters in a central station is often improperly done, and sometimes not at all, I do not think that Mr. White's method would be an improvement on either of the above cases. If so, it would be interesting to know how meters can be "properly tested" in such a variable circuit as he names. One generally requires a steady current from independent secondary cells, &c., to carry out meter tests, and even these currents have to be frequently adjusted by very sensitive resistances. Mr. White would understand better what I mean if he were to measure the current in a circuit such as he names, by means of, say, a Crompton potentiometer, taking readings every two or three minutes. I do not think that meters could be tested with any degree of accuracy placed in series with Mr. White's circuit, unless readings were taken about 30 times a minute, *or something more sensitive than an ordinary ammeter*, which, of course, could hardly be done. As the Board of Trade limit for a meter is within 3 per cent. each way (fast or slow), it is as well to make sure, when testing them, that the current passing through is a constant and known one.

C. J. Abraham.

Partick Electricity Works,
December 27th, 1901.

Examination Tests for Electrical Engineers.

A short time ago several letters *re* examinations appeared in your "Correspondence" columns. A certain well-known gentleman was, in a sense, invited to receive names of

persons interested, to which he generously responded. It is now almost a month since his letter appeared, but I have good reason for believing that his kindness has not been appreciated by a generous response. Why this should be so I am at a loss to understand, unless it is that some who have got decent positions don't care. I hardly think that it is because they have any fear of failing, but there are others, and I think that they are in the majority, who would be distinctly benefited by a test examination. Let us keep the ball rolling, seeing that it has made a start.

Progress.

Aluminium.

In your last issue you are good enough to publish an abstract of a paper entitled "Aluminium: Notes on its Production, Properties, and Use," recently read by me before the Glasgow Section of the Institution of Electrical Engineers. In that abstract you give one of the tables taken from my paper, and have added to it the following :—

	Copper.	Aluminium.
Equivalent price for equal section ...	1	3·37
Equivalent price for equal conductivity ...	1	2·03

appending a note to the effect that "these figures have been interpolated by us from another table not reproduced in this abstract." I would take the opportunity of pointing out that no figures given in my paper bear the interpretation you have attributed to them. It appears to me to be probable that you have assumed the figures in question from the data given in Table VI. The explanation of this table is given in the context. It shows, for different market values of copper wire, the *equivalent price per pound one could afford to pay* for aluminium wire, for either equal section or equal conductivity. The market values of both classes of wire, at any given period, being known, this table shows at a glance which of the two wires is the cheaper.

It is further stated that the current price of copper is about 10d. per lb., and of aluminium wire about 1s. 6d. per lb., from which figures, by the aid of the comparative table you give in your abstract, the two additions you have made can be calculated as follows :—

	Copper.	Aluminium.
Equivalent price for equal section	1	1·8 × 0·297 = 0·53
Equivalent price for equal conductivity	1	1·8 × 0·485 = 0·87

As your statement of the comparative figures is evidently an error, I should be much obliged if you could find space for this letter in your next issue.

W. Murray Morrison.

British Aluminium Company, Limited,
Foyers, N.B., *December 28th*, 1901.

Glasgow Exhibition Power Department.

We notice in last week's issue that in the description of Messrs. Belliss & Morcom's standard high speed engines, you mention that on many occasions their exhibit at the Glasgow Exhibition had to take the load from other sets with which the makers were experiencing trouble. As we were exhibitors at the same time and were running on the power and lighting circuit, we should not care for your readers to think that these remarks applied to ourselves.

As a matter of fact, our engine (No. 8) was the first engine to pass its 25 per cent. overload test, and this at the first trial. The engine was also the first engine to do any work at all in the Exhibition; the governing on the engine throughout the whole of the Exhibition was in every way satisfactory, the permanent drop in speed being three revolutions in 380 at full load, and we may also say that we ran through the whole of the Exhibition in a perfectly satisfactory manner, and none of the bearings were closed. The total number of hours that our engine was on load was 643 out of a possible 1,123. The first five weeks we ran every day until 10.30 at night without a standby. All the time the engine was running with the nuts taken off at the top of the holding down bolts, and at the close of the Exhibition the combined base of the engine and dynamo was 1¼ in. lower at one end than the other, owing to the faulty nature of the foundations. Of course we do not write this letter with the idea that you were imputing that any individual plant did not give satisfaction, but at the same time, knowing that our plant had run extremely well, we think it best to draw the attention of your readers to the fact. Messrs. Belliss & Morcom's productions deservedly stand very high in the estimation of electrical engineers, and it is not our intention in writing this to you that you should for a moment think that we think otherwise of them.

Browett, Lindley & Co. (1899), Limited.
WM. STEAD, *Director.*

The Tramway Junction at Sheffield.

The letter in your last issue signed "P. W. Askham," anent the above seems to be one of those things that would have been "better left unsaid." Whatever its object it was quite beside the mark. Every tramway engineer all over the country has probably heard about the junction at the Sheffield Post Office corner. It is unique in its character. I do not know another like it, and its recent re-construction distinctly marks an important advance in tramway special track work.

I will not reply to Messrs. Askham's letter. Messrs. Askham give their own case away in stating that their points, &c., after two years' running, were only a little above scrap heap utility.

This question, however, so far as we engineers are concerned, is not one to be argued for the ultimate benefit of any one manufacturer. Electric traction is in its infancy, and we all welcome any improvement upon our present methods. How is it the L.C.C., Glasgow, Manchester, Reading, &c., Corporations have all sent their special track work to America? Simply because English manufacturers are not up to date in the work. "What did 10 years ago will do to-day," they seem to think.

There is, therefore, absolutely no doubt that the Sheffield Corporation did a wise although a bold thing to adopt new work for this important corner in place of the old faulty points, &c., and engineers generally will watch with interest the behaviour of the new manganese material. If it succeeds it will once for all break through the absurd Hobson's choice system which has so far encumbered our work and allowed Americans to step in.

I have had the pleasure of meeting representatives of several American tramway works, men who possess the technical and engineering abilities to discuss a scheme in all its points. The "Commercial Traveller" one is so much used to is entirely absent, for talk to a practical engineer, and here lies one of the secrets of the success of American invasion into tramway work, regret it though we may.

Electric.

December 30th, 1901.

BUSINESS NOTES.

Dissolutions and Liquidations.—The Anderson Electrical Traction Syndicate, Limited, is winding-up voluntarily, with Mr. E. A. Mitchell as liquidator.

Messrs. A. H. Davies and J. Pollard (Stanley Davies & Pollard, electrical and general engineers, Hyde, Chester) have dissolved partnership. Debts will be attended to by the Pollard Electrical Engineering Company, who will carry on the business.

The partnership of Messrs. Jackson & Till having expired on December 31st, the business will in future be carried on in two separate departments. The india-rubber and gutta-percha departments will be continued under the style of Edward Till & Co. The rice department will trade as Jackson, Son & Co. Both firms will occupy the same offices as hitherto, so arranged as to keep the two businesses separate.

Ediswan Lamp.—The Edison and Swan United Electric Light Company, Limited, announce that they have received the honour of appointment by Royal warrant as purveyors of electric lamps to his Majesty the King.

The Fire at Gent's.—We are glad to learn that, the day after the fire which took place at their works at Leicester, Messrs. Gent & Co. were able to secure extensive adjoining premises, where they are immediately getting to work, so that little or no delay will take place in the execution of orders.

Electrical Wares Exported.

WEEK ENDING DEC. 25TH, 1900.		WEEK ENDING DEC. 24TH, 1901.	
Adelaide	Value £22	Alexandria	Value £67
Alexandria	64	Auckland	18
Amsterdam	55	Boca. Teleg. mat.	80
Bangkok	100	Bombay	151
Buenos Ayres	189	„ Teleg. mat.	60
Calcutta	919	Boulogne	59
„ Teleg. mat.	45	Buenos Ayres	36
„ Teleg. wire	167	Teleg. mat.	586
Cape Town	179	Cadiz. „ Teleg. cable	209
Demerara. Teleg. mat.	720	Calcutta	883
Durban	61	Cape Town	415
„ Teleph. mat.	99	Channel Islands	810
Fremantle	1,349	Chinde	12
Gibraltar. Teleg. mat.	19	Colombo	128
Hong Kong. Teleg. cable	83	„ Teleg. mat.	128
Kure. Teleg. cable	5,458	Copenhagen. Teleg. wire	49
Melbourne	1,248	Durban	705
Nagasaki	22	East London	177
Ostend	194	Halifax. Submarine cable	4,200
Paris	16	Hong Kong	242
Perth	133	Melbourne	580
Port Elizabeth	76	„ Teleg. wire	4,100
Reval	151	Rosario	35
Rotterdam. Teleg. wire	23	„ Teleg. mat.	429
Rouen	35	„ Teleg. instruments	893
Santa Cruz	79	Rotterdam. Teleg. wire	98
Shanghai	152	Santiago	105
Singapore	610	Santos	265
Sydney	2,316	„ Teleg. mat.	114
Wanganui	30	Singapore	17
Yokohama	106	Stockholm. Teleg. cable	167
		Sydney	6,759
		Yokohama	160
Total	£15,272	Total	£22,339

Foreign Goods Transhipped.

Gothenburg. Telephones	Value £12
Melbourne. Teleph. apparatus	45
Total	£57
Melbourne. Elec. mat.	Value £300

Electrical Wares Exported.

WEEK ENDING JAN. 1ST, 1901.		WEEK ENDING DEC. 31ST, 1901.	
Beira	Value £320	Adelaide	Value £514
Buenos Ayres. Teleg. mat.	133	Alexandria	186
Calcutta	900	Buenos Ayres. Teleg. mat.	100
Cape Town	246	Calcutta	1,237
Channel Islands	689	Cape Town	190
Christchurch	39	Channel Islands	150
Colombo	10	Christiania. Teleg. wire	51
Copenhagen. Teleg. wire	238	Colombo	10
Flushing	20	Copenhagen	34
Ghent	19	„ Teleg. wire	44
Gothenburg. Teleg. wire	12	Durban	352
Hamburg. Teleg. mat.	500	Fremantle	636
Madras	20	Hong Kong	30
Melbourne	115	Madras	80
Rosario	456	Melbourne	95
Valparaiso. Teleg. mat.	523	„ Teleg. wire	675
Zanzibar	88	Perth	14
		Rio de Janeiro	120
		Singapore	179
		Sydney	849
Total	£4,328	Total	£5,496

Foreign Goods Transhipped.

Brisbane. Teleph. mat. Value £100

Books Received.—*Science Abstracts* for December 26th, No. 48. London: E. & F. N. Spon, Limited. 2s.

"Mésures Electriques," by E. Vigneron. Paris: Gauthier-Villars. 3 fr. and 2 fr. 50 c.

"Discussion on the Teaching of Mathematics," British Association Meeting at Glasgow, 1901. Edited by John Perry. London: MacMillan & Co., Limited. 2s. net.

Journal of the Institution of Electrical Engineers, Vol. 31, No. 153. Edited by W. G. McMillan. London: E. & F. N. Spon, Limited. 5s.

Calendars and Catalogues.—We have received from Messrs. Mosses & Mitchell, of 68—71, Chiswell Street, E.C., a glass paper weight, which will, without fail, remind us of their vulcanised fibre sheets, insulators, &c., throughout the year.

A neat wall calendar, with daily date slips, comes to hand from the Deutsch-Atlantische Kabel Company (*viâ* Emden-Azores).

The Eastern and Associated Telegraph Companies have sent us one of their useful pocket memoranda books, with calendars for the next two years, details of the directorates and capital of the different companies, rates per word for messages, and a map showing their cable systems throughout the world.

A handy desk blotting pad is being sent out to the friends of the Hart Accumulator Company, Limited.

From the Electrical Company, Limited, we have received a descriptive pamphlet of their automatic controllers for lifts, for continuous and polyphase currents for voltages up to 500 volts.

The B.T.H. Company's pamphlet, No. 115 (December 23rd), deals with interchangeable enclosed arc lamps for alternating and direct-current circuits.

We are indebted to the International Electric Company for a handy little inkpot in the shape of a porcelain insulator.

Messrs. J. Halden & Co., of Westminster, have sent us a calendar, with monthly sheets, for the new year.

From Cryselco, Limited, of Bedford, we have received a new and abridged illustrated catalogue of the Cryselco lamp.

Messrs. Nalder Bros. & Thompson, Limited, have, as usual, forwarded us one of their calendars for the current year.

The Electrical Supply Company, of Hatton Garden, is sending out a useful metal plate calendar to stand on the desk.

Fire.—Last Saturday week, at 10.30 p.m., the West Ham Fire Brigade was called to a fire at Cook's Road, High Street. Several drums of electric cable and about 30 barrels of pitch and a quantity of timber had been placed in Cook's Road by workmen in the employ of the Charing Cross and City Electric Light Company, who are working in the neighbourhood. A spark from the watchman's fire ignited some of the pitch and wood, and in a few minutes there was a big blaze. The alarm was from the electric fire alarm post in Abbey Road, and two fire engines were quickly in attendance. Three drums of cable, and about 30 barrels of pitch and a quantity of timber were severely damaged.

For Sale.—The Hull Electric Lighting Committee wants offers for two Willans-Holmes steam dynamos, three "Economic" boilers, and other plant, of which particulars appear in our "Official Notices" to-day.

Institution of Electrical Engineers.—We are informed that, from January 1st, the telegraphic address of the Institution of Electrical Engineers will be "Voltampere, London."

Signalling.—It is announced in the daily press that the North-Eastern Railway Company have just placed an order with the Hall Signal Company, New York, for an experimental installation on the main line, near York, of a system of automatic electrical signalling.

Smoke Prosecution.—On 20th ult., at West London, Mr. Bodkin, on behalf of the Hammersmith Borough Council, appeared to support 12 summonses issued against the Central London Railway Company in respect of the issuing of black smoke from their chimneys at the generating station of the works in Wood Lane.—Mr. Horace Avory (for the company) said he had to make an appeal to the magistrate to be merciful. At present, the company were unable to comply with the law and to keep up the service of trains without making black smoke. He then proceeded to state that experiments were being made with Lancashire boilers, four of which were diminishing the cause of complaint at the western chimney. Already the company had spent £10,000 in alterations, and contemplated others which required to be carried out by degrees.—Mr. Rose said the only question to consider was the amount of fines to be imposed. It was a large and prosperous company, well able to pay the *maximum* fine, but he was of opinion that he ought not to enforce it, as it was clear they had not been contumacious, as the coal had been changed and the machinery altered. He saw no desire on the part of the company to be reckless in complying with the regulations of the Act of Parliament. He must impose fines to stimulate the company in these experiments, which he hoped would prove successful. He fined the company £5 in each of the summonses, amounting in all to £60, and eight guineas costs.

Trade Announcements.—Messrs. Baxter & Caunter, of 5, Macclesfield Street, Shaftesbury Avenue, W., who are sole agents for the Newton Electrical Works, Limited, Taunton, have also been appointed sole agents for the London, South and East Coast district for the Electric and Ordnance Accessories Company, Limited, Stellite Works, Cheston Road, Aston, Birmingham. The company are manufacturers of motor fans, traction switchboards, distribution switchboards, telephones, bells, and all electrical accessories, and Messrs. Baxter & Caunter are opening a warehouse, where they will stock large quantities of this material.

Messrs. Connolly Bros., Limited, of Manchester, notify that the arrangement under which the United Asbestos Company, Limited, represented their company in Scotland was terminated on December 31st, 1901. All communications from Scotland should be addressed to Messrs. Connolly's works at Blackley, Manchester, until further notice.

Mr. T. Harding Churton, of Leeds, notifies that the style of his firm in future will be T. Harding Churton & Co.

The Aberdeen Electric Engineering Company, Limited, which formerly carried on business in Schoolhill, has now entered into possession of new and extensive premises at 15, Belmont Street, Aberdeen.

We are informed that Mr. Alfred H. Gibbings is retiring from further association with the business of Messrs. Gibbings & Baker in favour of Mr. H. W. Appleby, who has had active interests in the business for the past six months. The title of the firm will, from January 1st, 1902, therefore be Baker & Appleby, by whom all accounts will be received, and all debts or other responsibilities taken over.

ELECTRIC LIGHT AND POWER NOTES.

Alloa.—The electric lighting of the principal streets of the burgh was begun just before Christmas, from the British Electric Plant Company's works. Messrs. Buchan & Hogarth are the engineers.

Bath.—An erroneous impression seems to have got abroad in connection with the recent switchboard failures at Bath. Reports have been published referring to serious breakdowns on the "old" and on the "new" switchboards, and rumour has attributed this trouble to the switchgear supplied by Messrs. Ferranti, Limited, but the facts of the case are that the original board supplied to the Bath Corporation was superseded last year by a new board of American make, and on a failure occurring on both of these boards, as stated in our issue of December 13th, Messrs. Ferranti were at once called in, and supplied, within three days of

the breakdown, one of their well-known high-pressure switchgears, which is already erected, and is now being connected up to the circuits.

Belfast.—A deputation of the Amalgamated Society of Engineers has waited on the Electrical and Gas Committee of the Corporation with reference to a resolution by the Committee passed 12 months ago, to fill the next vacancy in the electrical station with a qualified mechanical engineer. The deputation pointed out the risk of running new machinery without skilled engineers, and the constant attendance required. The Committee unanimously resolved to recommend the next vacancy to be so filled.

Bognor.—The U.D.C. has received a report by Mr. J. Enright, recommending the erection of an electricity installation at an estimated cost of £12,000, and a poll of the ratepayers is to be taken.

Carlton.—A scheme and plans having been submitted by the Nottingham Suburban Light Railway Company, asking permission to construct an electrical light railway between the Reading Room, Carlton, and the boundary on Swinton Hill, the D.C. has decided to assent to the scheme and gladly welcome a further extension. The cost is estimated at £7,806.

Coventry.—The electrical engineer, Mr. Jeckell, has reported to the Committee that, whereas for the six months ending September 30th, 1900, there was a deficit on the working expenses, apart from interest and sinking fund, of some £70, for the six months ending September 30th, 1901, there was a profit of some £370, on the same basis as last year.

Crieff.—Messrs. Crompton & Co., Limited, have submitted to the T.C. a draft agreement for leasing the Council's prov. order for electric lighting. The company will pay the cost of the order, and will charge 3d. per unit for street lighting and 6d. per unit for private supply.

Edmonton.—The D.C. has resolved to borrow up to £70,000 for electric lighting purposes.

Exeter.—The T.C. has approved of the report of the E.L. Committee recommending immediate progress with the new electricity works.

Glasgow.—The Corporation has entered into an agreement with the Glasgow and South-Western Railway Company to supply current for St. Enoch's Station and certain other premises in the city to an estimated extent of at least 660,000 units per annum, for a period of three years dating from June 1st, 1901, and thereafter from year to year, at the price of 1½d. per unit. A considerable portion of the above will be used during the day and the engineer, Mr. Chamen, assured the committee that at this figure—1½d.—they would have a margin of profit. The Railway Company had stated that unless they got it at this figure they would build works of their own.

The Caledonian Railway Company, who are also making extensive additions to their Central Station, are laying down a practically new generating station for electric lighting and power purposes. The voltage they have adopted is 220 volts, while that of the Corporation is 250 and 500 volts. It is evidently their intention not to become customers of the Corporation at any time, accounted for perhaps by the fact that they are always more or less at loggerheads with the Corporation.

Hornsey.—The D.C. has appointed Mr. Norman Staniland, of Canterbury, as clerk of the works and resident engineer at a salary of £250, rising to £300 on the starting of the electricity supply. The Council has also decided to vary the charge to 7d. per unit for the first 100 hours and 2d. after, and that the arrangement with the National Wiring Company shall be a rental of 6d. per lamp per quarter instead of 1d. per unit. As we have previously urged in these columns, a fixed rental is the proper method of charging, while a surcharge on every unit consumed is most unjust.

Hull.—The supply of energy to Messrs. Earle's shipbuilding yard is to be given by the Corporation at a price of 1½d. per unit for 300,000 units per annum, decreasing to 1d. per unit if the demand exceeds 1,500,000. Extra transformers, costing £2,780; mains, £6,000; and other apparatus, bringing up the total to £9,200, will be installed for the purpose.

Kettering.—The T.C. has decided to erect an electricity works and dust destructor, at a cost of about £50,000.

Kolar Gold Field.—According to the Madras mail, rapid progress is being made with the electrical equipment, much of which is already on the spot, having been imported from America. The high pressure transmission line has reached a point 46 miles from the Field, half way to the Cauvery Falls. The average rate of progress has been seven miles of line completed per week.

London.—ST. PANCRAS.—The engineer (Mr. S. Baynes) has submitted to the Electricity Committee a report as to the advisability of sinking artesian wells at the generating stations at Regent's Park and in King's Road. It is estimated that the expenditure would amount to about £2,200 in each case. As the present consumption of water costs £600 per annum, and as the use of soft water would prevent scaling of the boilers, the Committee has recommended the Council to sanction the expenditure.

Some months ago the Borough Council convened a conference of the other Metropolitan Councils to consider the requirements of the Postmaster-General as to the plans showing the position of mains, when it was decided to appoint a deputation to wait upon the Postmaster-General. The deputation pointed out that the request to be supplied with maps 10 ft. to the mile, showing positions of mains, &c., was unreasonable, and in many cases impossible. The deputation therefore suggested:—(1) That the information required would be much better supplied in the form of a pocket-book as kept by most engineers, giving the distance of the mains from the building line or edge of kerb, width occupied by them and their depth; (2) that if maps were to be supplied the Postmaster-General should be satisfied with maps on a large scale of those roads and streets through which he was desirous of laying mains, and that plans of service boxes could only be furnished after laying, as in many cases the shape depends upon the nature of the ground. It is thought that the Postmaster-General will adopt one of these suggestions.

STOKE NEWINGTON.—Owing to the small size and rateable value of the borough, the Council has decided to take a supply of electricity in bulk from the adjoining boroughs of Hackney and Islington.

POPLAR.—The Millwall Docks Company have entered into an agreement with the Borough Council for lighting the docks by electricity. It is estimated that half a million units per annum will be required. The Council will also supply the City of London Infirmary, which is within the bounds of the borough, at a rate of 3½d. per unit.

ISLINGTON.—With reference to the explosion of gas which occurred in the electric lighting conduits in Highbury Park on October 8th, the Lighting Committee recommends that proceedings be taken against the Gas Light and Coke Company for the damage sustained by the Council in consequence of the explosion.

STEPNEY.—A conference of representatives of the Borough Councils has been held at the Stepney Town Hall to consider the decision of the Divisional Court, that electric lighting inspection chambers and street boxes are within the scope of the London Building Act, and notice of intention to construct them must be served upon the district surveyor, who is entitled to the statutory fees for "supervising the work." The conference adopted a resolution "that united action be taken by the Metropolitan Borough Councils for the transfer to them of the duties now exercised by the district surveyors under the London Building Acts, so far as those duties refer to electric lighting boxes and similar constructions under the public way."

Maidstone.—The new electricity works, which was opened last month, was erected to the designs of Messrs. Stevens and Barker, and contains five boilers, five steam dynamos (four of 150-KW. each, and one of 75-KW.), and a battery of 280 Chloride cells. The three-wire system is in use, and the streets are lighted with 44 Brockie-Pell arc lamps.

Manchester.—At a recent meeting of the Electricity Committee it was stated that excellent progress had been made in connection with the new generating station in Bloom Street. The second 3,000-H.P. generating set has already been started, and will enable the department to speedily meet the wants of customers now waiting for current to the extent of over 50,000 8-C.P. lamps. The Committee had under consideration the question of tenders for the provision of 12 boilers, with economisers and feed-pumps, for the supplementary installation, equal to 12,000 H.P., designed by Mr. Metzger, the chief electrical engineer, for the station at Stuart Street. It should be stated, in regard to the tenders for boilers, that an advertisement, with specifications, was prepared by the Committee, and was published on November 15th. It was requested that tenders should be in before noon on December 4th. Between November 15th and that date, however, it was discovered that the specification stated that "each boiler is to be fitted with Babcock & Wilcox's superheater, having a heating surface of 509 sq. ft.," and that words which should have followed—"or other approved type,"—had been omitted. It was obvious that the clause, as it stood, restricted competition, and it was resolved by the Committee not to open the tenders which had come in, but to issue fresh specifications, leaving out entirely the names of Babcock and Wilcox. The clause, in its amended form, read, "each boiler is to be fitted with a superheater having a heating surface," &c. The amended specifications were issued on December 7th to all persons who had applied for copies of the original specifications and had paid the customary deposit of five guineas, free of charge. The error was pointed out to them, and they were asked to tender afresh, and to revise their tenders if they thought necessary. The tenders received were adjudicated upon, and the Committee recommended the Council to accept that of Messrs. Babcock and Wilcox, as being absolutely the lowest tender. With regard to automatic stokers, the original specification stated that "the stoking gear is to be of the chain-grate, coking, or other type," so that no limit was placed upon contractors, who were at liberty to use whatever type they thought proper. The Committee recommended that the contract for coal economisers should be placed with Messrs. Green, of Manchester, and that for feed-pumps with Messrs. Blake and Knowles, of London. These contracts will come before the City Council for approval or otherwise at the next meeting.

Oban.—The T.C. is inviting tenders for works in connection with the erection of an electrical generating station.

Pemberton.—Just before Christmas the D.C. inaugurated the new electric lighting installation, which has cost about £20,000.

Quebec.—The submarine cable which is to convey power from the Levis side to Quebec, was laid on December 12th. The work was commenced shortly after 8 o'clock, the Ferry Company's steamer *Queen* clearing a way through the ice, followed by the *M. F. Hackett*, from which the cable was dropped into the river. It took 20 minutes to perform the work.

Southport.—The accounts of the six years' operations of the electricity works show that during the past year the demand has again made good headway, the number of new lamp connections exceeding that of any previous year. The figures in 1900—1 had risen to 910 consumers, 56,780 lamps, and 1,023,970 units sold. In the wages and management expenses substantial economies have been effected, the total costs being 1·65d. per unit. The larger output has improved the receipts, but the yield on gross profit on capital employed has been reduced. Still the return was sufficient to pay the interest charges, to provide 2·97 per cent. of the average capital for its redemption, and to leave a balance of £695 to the good. On March 31st, 1901, the capital expenditure amounted to £133,036, and the amount expended in the 12 months ending March 31st, 1901, was £30,290. The traction charges average 1·74d. per unit, and the rates for both heating and power are 4d., reducing to 2d.

Sydney.—The City Council has approved of the purchase of a site for the electricity works in Pyrmont for the sum of £13,300, and has resolved to authorise the consulting engineers, Messrs. Preece and Cardew, to proceed with the electric lighting scheme.

Swansea.—The Corporation quoted 1⅛d. per unit for lighting the harbour by electricity, but the Executive Committee of the Harbour Trust has decided to recommend the rejection of the Council's offer, and that an independent scheme be proceeded with.

West Bromwich.—The E.L. Committee of the Corporation recommends that immediate application be made to the L.G.B. for sanction to borrow the sum of £8,500 to meet the cost of extension of the new electricity works, in order to provide the energy required for the working of the trams.

ELECTRIC TRACTION NOTES.

Aberdeen.—The Tramways Committee has in view a £30,000 scheme for tramways extensions.

Baker Street and Waterloo Railway.—It is stated that, in its uncompleted state, this railway has been sold, and the purchaser is no other than Mr. Yerkes, who may complete and use the line as part of his new underground system, which includes the District, the Brompton and Piccadilly, the Charing Cross and Hampstead, and other railways. The price, it is stated, exceeds a quarter of a million.

Birkenhead.—The B. of T. inspection of the Dock electric tram route was made by Lieut.-Col. Von Donop last week. The line was afterwards opened for public traffic.

Bournemouth.—The Town Council has sanctioned the scheme for extending the electric tramway to Southbourne.

Bristol.—The City Council on Wednesday had presented to it a report from the Special Committee charged with inquiry into the purchase of the electric tramways. The Committee was formed on the suggestion of Alderman George Pearson, not with the idea of compulsory purchase, but because there was an impression that the company was not unwilling to negotiate with a view to the acquisition by the city. The figures furnished by the company as the basis for a sale were, however, such that the Committee could not recommend the Council to accept. There the matter ends. The balance of the term before the city can purchase under the powers of the Tramways Act is between 13 and 14 years. The company have 30 miles of tramways and 232 cars in use. They have a large manufacturing and repairing depôt at Brislington, a number of smaller depôts, a fine new power station, and a smaller power station at St. George's. It is understood that the price named by the company approximated to 2¼ millions.

Carshalton.—The B.E.T. Co. have declined to supply the local Ratepayers' Committee with copies of their lithographed plans for tram routes, saying that they can only supply the same to persons who have already decided not to oppose their scheme.

Central London Railway.—Serious inconvenience was caused on Monday by a mishap on the Central London Railway. It appears that just before five o'clock in the morning, a motor was being shunted into the Bank Station to take the first train to Shepherd's Bush, when, though going dead-slow, some part of the gear apparently fouled the current rail, and it jumped the points just where the two tunnels join, and effectually prevented any train entering or leaving either. The nearest "cross-over" by which trains could be shunted from one line to the other was at the British Museum Station, and this was made the temporary City terminus, a 3½-minute service being maintained to and from Shepherd's Bush. The space in the tube is so small that it was with the utmost difficulty that the engine, which weighed 44 tons, and was resting against the side of the tunnel, could be moved. It was not till five o'clock that the line was cleared and traffic resumed.

Dewsbury.—The B.E.T. Co. are now in possession of the Dewsbury, Batley, and Birstall (Steam) Tramways. A special meeting of the directors of the local company was held on Thursday, December 19th, for the purpose of meeting representatives of the B.E.T. Co. The transfers of the shares of those shareholders who agreed to sell to the Traction Company were passed, and the management of the line was formally transferred to that company. The directors of the local company resigned, and new directors (all London gentlemen) were nominated for election in their places. Mr. Laxton retains his position as secretary, and for the present there will be no change in the running of cars, or the matter of fares, working staff, &c. About $\frac{19}{20}$ths of the shares of the old company are now held by the Traction Company. The Batley Corporation have powers to purchase the section of the lines within their borough, and it is stated that the recent transfer will not affect the Corporation's position. Negotiations, however, are now proceeding between the Traction Company and the Batley Corporation for the leasing of the lines to the company. The Corporation have incurred costs amounting to about £3,000 in obtaining powers to purchase their section of the line and in opposing the Traction Company, and it is now held by many people that they are in no better position than they would have been had they agreed with the company two years ago. The new directors have made important alterations in the working of the system as regards fares and frequency of service.

Douglas.—The House of Keys has granted the petition of the Douglas Town Council that the Council be empowered to borrow the sum of £52,000 with which to carry out the purchase of the Bay and town sections of the Douglas tramways.

Durban.—A syndicate has applied to the Corporation for the rights to construct electric trams for the Umgeni district, connecting with the Corporation line.

Eastbourne.—The E.L. Committee has prepared an electric tram scheme.

Electric Tramways and the Snow.—The recent heavy snowfalls in the Tyneside and Wearside districts have most injuriously interfered with the tramway traffic in both areas. In Newcastle, which is further removed from the sea than is Sunderland, the snow lay much more readily, and with the heavy gradients, traffic was soon stopped. In Sunderland, where the gradients are much easier, and the hills considerably shorter, the traffic was in part impeded within four hours of the fall. No attempt at all adequate was made to deal with it as it fell, and as a consequence, by 2 o'clock in the afternoon two cars were off the metals, one at Roker, the extreme north-east end of the town, and the other at the west end, on Hylton Road section. Later, another stoppage occurred on the Grangetown section, and generally, the running was most irregular. Several members of the Sunderland Tramways Committee were very wroth at the stoppages, most of which they considered to have been preventable, and they are taking steps to provide wooden snowploughs, and are considering other means of coping with future falls. The Cleansing Sub-committee of the Health Committee are responsible for the street cleaning, and the Tramways Committee think they should have charge of the track.

Gloucester.—Mr. Alfred Dickinson, acting for the Corporation, will confer with Mr. Samuel White, managing director of the City of Gloucester Tramways Company, with reference to the value of the company's system, and as to the terms of purchase. He will afterwards advise the Corporation as to the advisability of taking over the system.

Greenock.—The Greenock and Port Glasgow Tramways Company have refused to take the question of running cars on Sunday to arbitration, and the Greenock Town Council have now decided to obtain legal opinion on the points in dispute before going further.

Hamburg.—It is stated that Messrs. Siemens & Halske, the Berlin General Electric Company and the Hamburg General Tramways Company have entered into an agreement to form a company with a capital of 15,000,000 marks for the purpose of constructing and working electric tramways in Hamburg and suburbs. This agreement has just been ratified by the Hamburg State authorities.

Isle of Man.—The electric sections of the tramways belonging to the Isle of Man Tramways and Electric Power Company, Limited, in liquidation, have been sold for upwards of £250,000. A Manchester syndicate is said to be the purchaser. In September last an offer of £188,850 was made for the sections when they were submitted for sale by public tender. The sections in question are those between Douglas and Laxey, Laxey and Snaefell, and Laxey and Ramsey. The sale of the properties will, it is said, admit of a dividend of 10s. in the £ being paid to creditors of the company, but the ordinary and preference shareholders will not get anything.

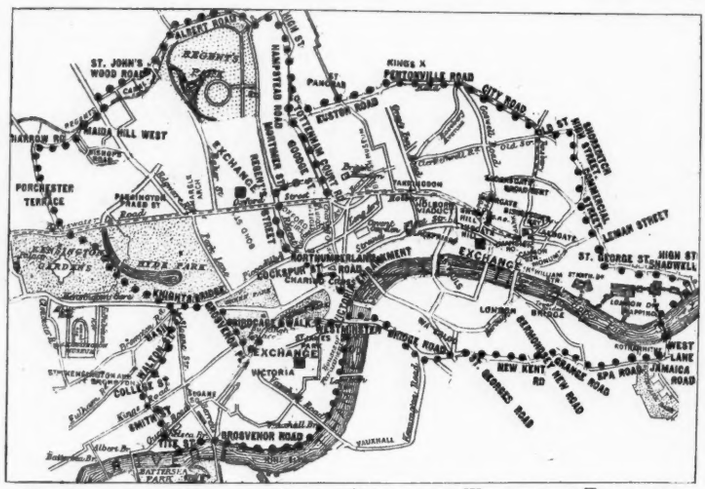
Keighley.—The liquidator of the Keighley Tramways Company, Limited, has paid a first and final dividend of 11s. 8d. per £1 share to the shareholders out of the proceeds of the sale of the undertaking to the Corporation.

(*Continued on page* 23.)

THE CENTRAL EXCHANGE OF THE LONDON POST OFFICE TELEPHONES.

(*Concluded from Vol.* 49, *page* 1049.)

Having shown how a second exchange is called up from the Central, we shall assume that the process is reversed, and that a call originating at a district common-battery exchange is to be dealt with on the junction board at the Central. A reference to the diagram below will show that the two exchanges are, so far as the speaking circuit is concerned, mechanically isolated from one another, communication being effected entirely by induction through the repeating coils. The latter, again, on the line side at the Central Exchange, are not connected with a battery, but only through a condenser for speaking currents, and through a relay for signalling currents. The diagram indicates the multiple jacks at the originating exchange, which are dealt with by the operator there, as already mentioned. The junction lines are joined to the repeating coils at the Central Exchange, and being connected with the battery at the first exchange, they convey a current to the fine wire coil of the relay, R, which has a resistance of 12,000ω. The current—about 2 milliamperes—is too small to actuate the clearing relay at the originating exchange, so that the clearing lamp there glows; the relay at the Central, however, is operated, closing the circuit from the battery to earth through the clearing lamp and two resistances of 40ω and 80ω respectively. While this is taking place the Central operator has tested the subscriber's jack with the tip of the plug, and, if he is disengaged, has inserted it and pressed the ringing key. This, it will be seen, connects the generator to the subscriber's line through the interrupter, sending intermittent calls automatically. The ringing key is self-locking, as indicated, so that the operator is free to attend to other calls; directly the wanted subscriber takes his receiver off the hook the resistance of his circuit is reduced, so that the current from the generator becomes strong enough to actuate the magnetic release shown in the figure.



Map Showing the Central, Oxford Street, and Westminster Telephone Areas and Exchanges.

The insertion of the plug into the jack allows a current to flow through relay R_2, which has a resistance of $83\frac{1}{2}\omega$, in series with the clearing lamp and cut-off relay *viâ* the bush of the jack. The operation of the relay shunts the clearing lamp at the Central Exchange with a resistance of 40ω, so that this lamp goes out directly the plug is inserted. At the same time, the relay connects the tip and ring of the plug respectively with the repeating coil through the ringing key, as soon as the latter is released by the subscriber's reply. The current which then flows actuates the 10ω relay R_1, which throws the 20ω coil of relay R into action; the current flowing from the originating exchange then increases, and operates the relay at the originating exchange, so that the clearing lamp there goes out. The circuit is then ready for speaking, and the subscribers are "through," as shown in the small diagram on the following page.

Should the operator require to speak to either of the subscribers, she would have to press the speaking key shown in the diagram. This, it will be seen, would connect the operator's head set with the subscriber's circuit.

In the event of her speaking to the calling subscriber before the wanted subscriber had answered the call, the ringing key would still be coupled up to the generator; the act of closing the speaking key, however, automatically puts the

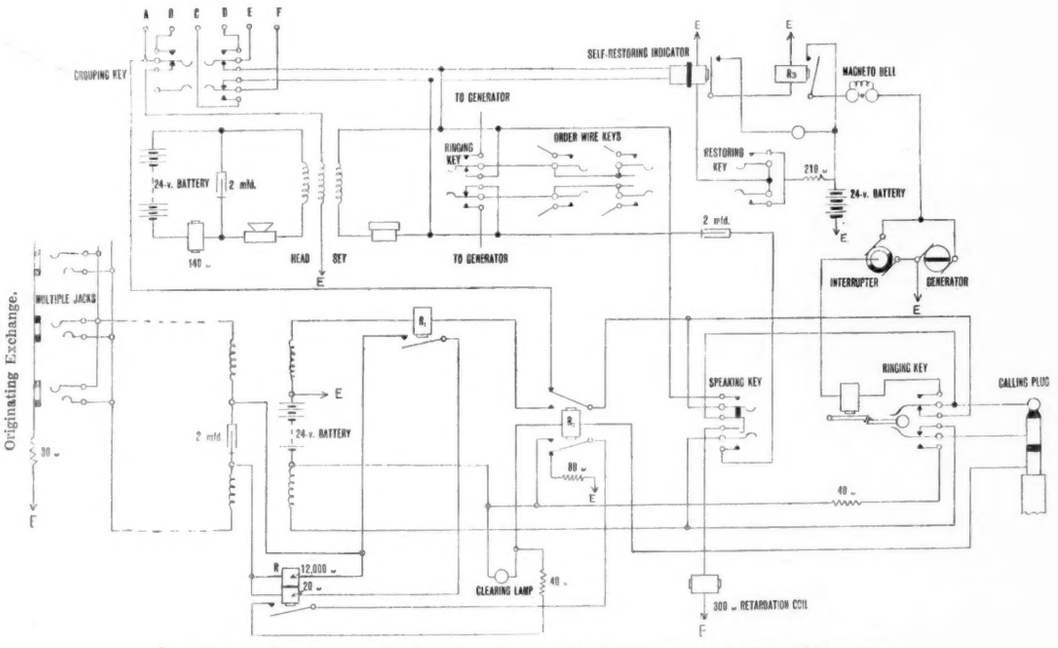


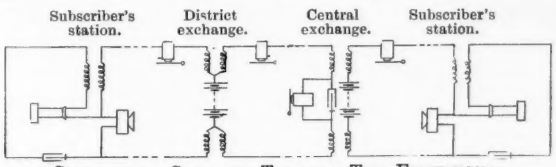
Diagram of Connections of Junction Operator's Keyboard at Central Exchange.

spring of the ringing key to earth through the 300 ω retardation coil shown, whereby the magnetic release of the ringing key is actuated and the generator cut off.

In the ordinary way, however, no speaking is required;

View of Trench and Ducts.

if the wanted subscriber's line is engaged, the operator at once ascertains this by the test with the tip of the plug, and signals the fact to the operator at the originating exchange by inserting the plug in one of the "busyback" jacks, to which reference has already been made. The effect of this is to transmit a regular intermittent tone signal to the operator at the first exchange, which causes the clearing lamp in the cord circuit to fluctuate in brightness; this attracts the operator's attention, and after verifying the signal by throwing the speaking key, she informs the calling subscriber of the fact that the line is engaged, and clears the connection. Similarly, if the wanted subscriber fails to answer the call within a reasonable period, the central



Subscribers Speaking Through Two Exchanges.

operator removes the plug from the subscriber's jack, and inserts it in one of the "don't-answer" jacks, which sends a tone signal of unequal beats to the originating exchange, with like results. In many exchanges the subscribers understand these tone signals themselves, as they are audible at their stations, so that no intimation that the line is engaged, or that no answer is received, is required on the part of the operator.

Supposing that a conversation has taken place, if either subscriber hangs up his receiver, his clearing lamp at the originating exchange lights up; when both hang up, the operator sees both clearing lamps alight, and clears the connection, just as if a local circuit were in question. Directly this happens, relay R at the Central ceases to hold its armature, so that the clearing lamp lights up, showing the Central operator that the conversation is over. The operator therefore clears the connection at the junction board, and the transaction is completed.

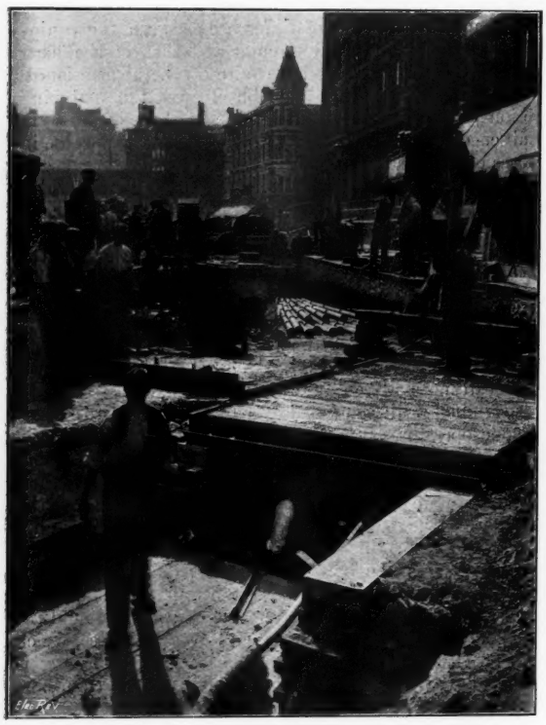
There are several points of difference between the equipment of the junction board circuits and that of the local boards. Some of these have already been mentioned. It will be noticed that the bushes of the outgoing junction jacks are earthed through a resistance of 30 ω, in the absence of the cut-off relay which serves this purpose in the case of local jacks. Again, in order to give the engaged signal at the junction board, a tertiary winding is provided on the induction coil of the operator's head set, which is connected to earth, and to the tip of the plug, as shown. The self-restoring indicator is only required at night, when the operator is not constantly listening on the call wires. The latter are connected to the terminals E, F; the terminals C, D, which are joined to the outer springs of the grouping key, are connected with terminals E, F at the next operator's position, and so on. Hence, if the grouping key is thrown over, a call normally received at the position where the call wires terminate will be carried over to the next position, so that one operator can deal with both positions. As the grouping operation may be repeated again and again, any number of adjacent positions may be thus thrown together, in one or more groups. It will readily be seen that the operation of the indicator closes a local circuit through a lamp and relay R_3, which again connects a magneto bell with the generator *viâ* the battery and earth. The function of the bell is, as already explained, to attract attention; the lamp indicates the position where the call is received, and the key enables the operator to actuate a restoring device, which shuts off both bell and lamp. The tip of the plug is connected with terminal A, while terminal B is connected with terminal A at the next adjacent position, and so on, so that the same movement of the grouping key which transfers the call wires to the next position on the right-hand, also

Gas Mains, &c., in Victoria Street, Westminster.

connects the tips of all the plugs with the tertiary coil of the head set at the latter position.

In some cases it will be necessary not only to receive calls from other exchanges on the junction board at the Central, but also to call up other exchanges from it, thus trans-

mitting calls from one district exchange through the Central Exchange to another district exchange. For this purpose



Roofing Cable Subway in Queen Victoria Street.

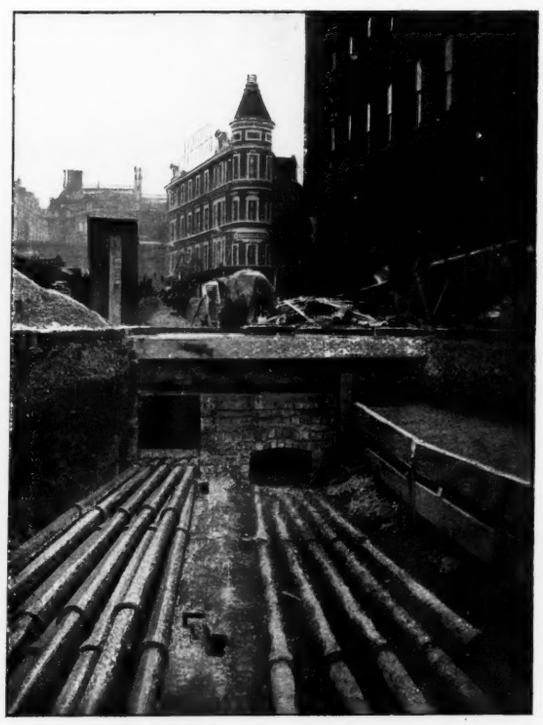
order wire keys are provided, which are used exactly as those at the local positions, and are shown in the diagram.

Besides the junctions for communication with other common-battery exchanges, described above, provision is also made for communicating with exchanges on the Post Office permanent-current system, together with exchanges of the National Telephone Company, and with the trunk line system. The switchboards provided for these services are generally similar in appearance to the common-battery boards, but differ in the details of the connections. Having described the principal types of board in detail, we do not propose to deal in the same way with the other boards, as to do so would involve a lengthy explanation of the methods of working of the permanent current exchanges and trunk lines. We should add that the whole of the equipment of the Central Exchange has been carried out, under the supervision of the staff of the Post Office, by the Western Electric Company, on the system which they have developed and brought to perfection.

A few notes about the out-door work which has been carried out, may be not without interest.

The area served by the Central Exchange is shown on the map on p. 18, which also shows the areas dealt with by the similar sub-exchanges, now far advanced towards completion, at Westminster and Oxford Street. The method of laying the earthenware ducts, and the type of cable employed, were fully described in our issues of May 11th and 18th, 1900; since then the bulk of the underground work has been accomplished. Naturally the heaviest part of this lay in the vicinity of the Central Exchange and in the main thoroughfares passing through the City. One of our illustrations shows the normal method of laying the ducts, where little obstruction is met with; but this is seldom the case for any great length, and another view, taken at the bottom of a trench in Victoria Street, Westminster, will give some idea of the extraordinary difficulties which had to be overcome. In many cases the obstacle could be burrowed under, as in the last mentioned, some of the trenches attaining a depth of 28 ft. (for example, in New Bridge Street). Very often, however, this was not feasible. In Queen Victoria Street the subways provided by the Corporation for pipes and cables proved to be very inconvenient; the telephone cables leaving the exchange were too numerous to be accommodated inside them, as they were full already, and it was necessary to take 90 pipes over the top of a branch subway crossing the street, as the subway rested direct on the Metropolitan Railway tunnel. One of our views shows the subway being roofed over with iron troughing, and the pipes ascending from three apertures in the wall of the principal manhole. Another view in the same direction—looking from St. Andrew's Hill towards the *Times* office—shows the pipes more clearly. The trench was 24 ft. wide at the shallowest part (over the subway), where the pipes were arranged in two layers. A vertical section at this place would have shown the telephone ducts, the cable subway, the Metropolitan District Railway, and the Waterloo and City Railway, one above the other! The pipes, after topping the subway, are divided between three trenches, each 10 ft. wide, which eventually are brought one above the other. Some of the telephone cables, for local service, are diverted into the subways which run along the Embankment; the bulk run along New Bridge Street, where the old and new Fleet sewers were met with. The Holborn, St. Bride's Street, Embankment, and Central London (Mansion House) subways were made use of. It is important to note that all footways near the manholes are already provided with three 4-in. pipes each, for service connections, so that reopening the roadways for connecting up subscribers will not be necessary.

At certain points the traffic was so dense and so important that it was considered out of the question to open the roads, and therefore it became necessary to drive headings underground for the purpose of installing the ducts. All the ducts from Threadneedle Street, Lombard Street, Cornhill, and King William Street meet in the Mansion House subway and are led through a tunnel of this kind, 120 ft. long, under the road in front of the Mansion House to Walbrook, on their way to the Central Exchange. This tunnel was cut entirely from one end. A similar tunnel between Moorgate Street and the top of Old Jewry, 180 ft. long, was driven from both ends. The ducts were laid in these tunnels, and the spaces filled up solid with tamped concrete.



Cast-Iron Pipes for Telephone Cables between Manhole and Cable Subway, Queen Victoria Street.

In St. Paul's Churchyard the ducts dipped 22 ft. under a sewer built by Wren, 4 ft. in diameter, to carry off the

rain water from the roof of the Cathedral to the old Fleet sewer at the foot of Ludgate Hill. East of St. Paul's the excavators came across the steps from the old Cathedral to

Laying Ducts on London Bridge.

he street, at a depth of 10 ft. Old cloisters were found at the south porch of the Cathedral, in made ground, and down Ludgate Hill massive walls, with archways of chalk, were discovered, of considerable length.

From Paternoster Row a tunnel was driven to the G.P.O. West, and in the process the old pneumatic tube was come upon. The difficulties due to pipes, &c., at this point were exceptionally great. The longest draw-in occurs close by here, between the G.P.O. West and Warwick Lane, 213 ft.

Old wooden water mains were met with in various places in a good state of preservation; they consist of rough trunks, 18 in. to 24 in. in diameter, with a bore 6 in. in diameter. The joints are simply butted, one end being hollowed out conically, and the other tapered to fit. Five of these mains, side by side, were found leading to Newgate and Gray's Inn Road.

Some difficulty was encountered in crossing London Bridge, owing to the small space available for manholes, but this was overcome when large culverts were discovered in the piers. As shown in our views, the ducts, 16 in number, were divided into two groups of eight each, in two layers over the summits of the arches. The division was necessary for convenient handling in the culverts, where the cables are supported on racks. The culverts were converted into manholes by the simple process of putting in steps and manhole covers, and the cables are jointed in each manhole.

The above will serve to briefly indicate the kind of work that had to be done by the engineering staff of the Post Office, but barely touches upon the many interesting discoveries and difficulties that cropped up. To meet with 24 pipes, ranging in diameter from 18 in. to 2 in., in a length of 16 ft., was regarded as little out of the common!

In concluding this article, we have pleasure in tendering our thanks to Mr. J. Gavey for the facilities and photographs necessary for its preparation. We cannot omit to also express our hearty appreciation of the unfailing courtesy and welcome which we received, at the hands of the many members of the Post Office engineering staff who have afforded us their kind assistance.

Banquet.—The foremen of Messrs. Siemens Bros. and Co.'s, Limited, Woolwich works held a banquet at the Holborn Restaurant on Friday, December 20th, when the managing director, Mr. G. von Chauvin, occupied the chair and Mr. Alexander Siemens the vice-chair. After the banquet a capital programme of music was got through by some of the employés and local artists, which was very much appreciated.

MACHINE TOOLS AT THE GLASGOW EXHIBITION.

(In Special Reference to the Requirements of Dynamo and Motor Manufacturers.)

By FRED. BATHURST, A.M.I.E.E.

(*Continued from Vol.* 49, *page* 1084.)

The Yankee Drill Grinder.

The old-established firm, Messrs. Buck & Hickman, of Whitechapel Road, London, E., had, as would be expected, a large and representative exhibit of American automatic machinery and tools. Many of these tools were shown in operation, but being well known to English engineers, will be passed without special consideration.

Although many good points could be referred to amongst the small lathes—turret and automatic—which were exhibited, perhaps the one exhibit which should be picked out for special reference on account of its general necessity and universality of use, is the "new" Yankee drill grinder.

Those machine shops whose wide-awake superintendents early seized upon the advantages of twist drills, soon found that such drills, when new, undoubtedly gave good service, but difficulties occurred when machinists of ordinary calibre had to re-sharpen them. American ingenuity however, soon produced a tool consisting of a grinding wheel and holding device which would allow a comparatively unskilled workman to grind a twist drill at a correct angle so as to sharpen it efficiently.

Such sharpening tools have been introduced to many machine shops, but as in all classes of machine tools, designers' brains are continuously employed on improvement, and comparatively recently a new type of drill grinder, style F. (as illustrated in fig. 17), has been put on the market, which it is believed will soon supplant all other styles in shops using twist drills ranging from medium to large size.

The advantage of a wet drill grinder over the original form, which was a dry one, is, that the temper of the drills cannot be drawn, as so frequently occurred when an ordinary mechanic was using a dry wheel. Time is also saved when the drills have become quite blunt or broken. With the wet

The Central Exchange.—Ducts on London Bridge.

wheel the grinding can be forced as fast as the wheel will cut, without any possibility of softening the drill, and it, therefore, grinds with maximum efficiency, and as the temper

of the drill is not withdrawn it can be sharpened in the least possible time. A simple pumping arrangement delivers water at the centre of the grinding wheel, with a uniform

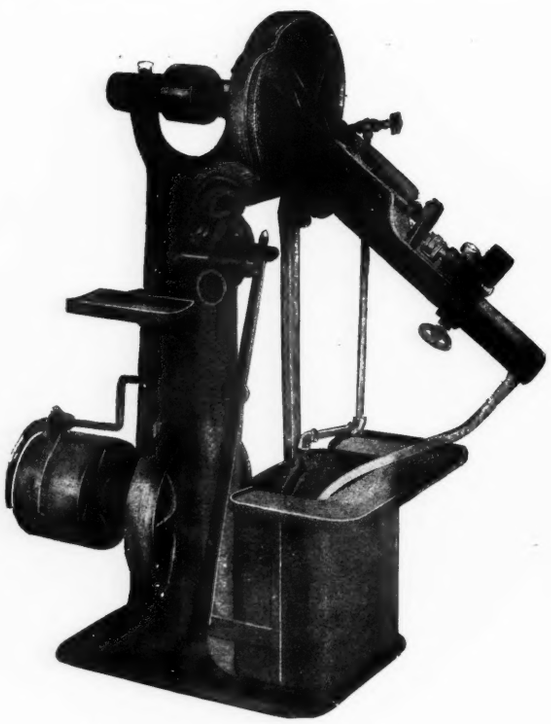


FIG. 17.—NEW YANKEE (WET) DRILL GRINDER.

distribution, and without splashing, the over-flow being returned to the tank from the lower end of the tool-holder by means of a flexible hose.

Messrs. Buck & Hickman issue a well-written pamphlet (by the Wilmarth & Morman Company, U.S.A.), which, whilst describing the various types of drill grinding machines, gives an interesting note on scientific drill grinding generally, pointing out that in a correctly ground drill, the amount of clearance must steadily increase in regular ratio from the periphery to the drill centre, for the nearer we approach the centre of the drill, the smaller will be the circle described by a point on its cutting edge as the drill rotates; but as the drill advances with equal speed into the metal, whether at its centre or its periphery, all portions of the cutting lip cannot cut with equal freedom unless the clearance at the given point bears a proper relation to the circumference of the circle it describes whilst rotating, and the speed also at which it is being fed into the metal.

Twist drills, from No. 60 gauge to 5 in. diameter, are now in common use in modern machine shops, and looking to their immense utilisation, and the amount of time that can be lost or gained by a clear understanding of their principle of application, the above brief excursion into "scientific" drilling will, it is hoped, be useful and instructive.

RADIAL ARM DRILLING AND TAPPING MACHINES.

MESSRS. LOUDON BROS., of the Clyde Engineering Works, Johnstone, Scotland, had a very valuable exhibit of the special and general machine tools of their manufacture. Whilst they make elaborate special machines for particular classes of customers, they recognised that only a limited number of people would be interested by them, and their exhibit was designed to include all the more important tools needed in almost every engineering workshop. This firm's endeavour is to combine the handiness which is the leading feature of American tools, with the rigidity usual to that of the best British manufacture.

Not having space to touch upon the many tools exhibited, the above feature is, perhaps, best shown in their radial drilling machine (see fig. 18). This machine is self-contained, being driven from an electric motor incorporated upon the machine bedplate. The motor employed is one of 3 H.P., and drives through a raw hide pinion on to a large spur wheel arranged on the main shaft cone of the machine.

The gearing is arranged so that a change can be made from single to double gear or *vice versâ* by the simple movement of a lever. This improvement saves much time to the operator. An index table is provided upon the frame of the machine which gives the correct driving position for the belt according to the varying diameter of the holes being drilled, which enables an unskilled labourer to operate the machine as efficiently as the high-class workman. The hand motion of the spindle is arranged so that this may be rapidly raised or lowered by the same wheel which is used for the slow feed, and, when tapping, the feed wheels may be thrown clear of the spindle, which is then left free to follow the tap. This saves breakage of taps.

A special arrangement provides that when tapping, the speed of the spindle can be instantly reduced to one-third of the drilling speed, so that there is no necessity to operate the belt or change gear. Adjustments are provided so that the only wear that takes place on the drilling spindle is that due to the vertical sliding movement, which, of course, is a minimum. The radial arm saddle can move through a distance of 3 ft. 7½ in. by means of a rack and pinion, and cross travel, whilst an efficient locking device is provided. Both spindle and radial arm are provided with ball bearings, which ensure free and easy movement.

The column pole-plate and radial arm are all of particularly massive design, and when these machines are not electrically driven, they can be provided with fast and loose pulleys for ordinary shop shaft driving. The machine shown has a 2½ in. diameter spindle, and a self-acting feed

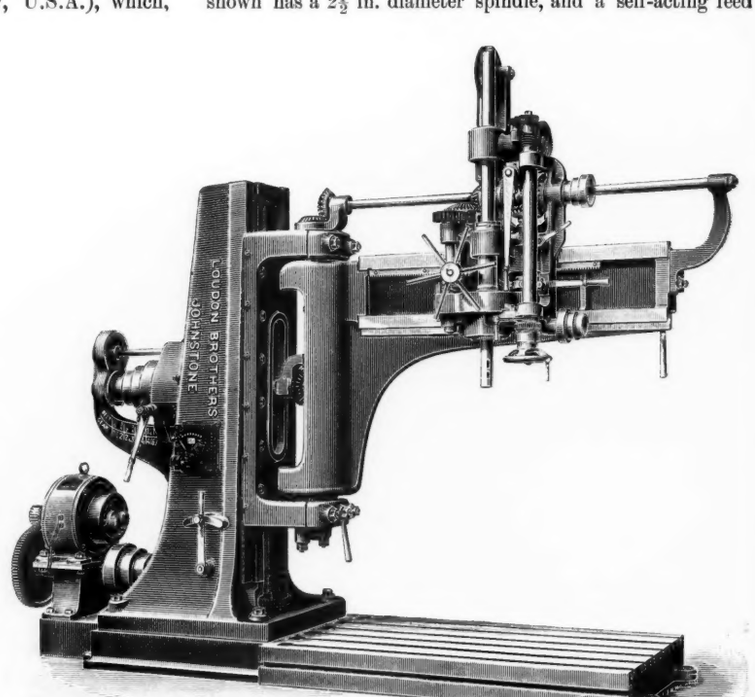


FIG. 18.—LOUDON BROS.' RADIAL DRILLING MACHINE.

motion by rack and pinion of 18 in., the radial arm having a vertical movement of 23 in. upon the column casting.

Other types of the same machine are made having a 3-in. spindle with 7 ft. radius.

The illustration of this machine speaks for itself, but the Scotch makers prefer to invite the attention of their friends to the machines themselves, and can provide lists of machine shops showing that their tools can be found at work all the world over.

(To be continued.)

ELECTRIC TRACTION NOTES.

(Continued from page 17.)

Bradford.—The Corporation is giving a trial to an improved method of reversing the trolley which is the invention of Mr. J. W. Oldfield, of Thornbury, Bradford. It is a mechanical arrangement on the car for shifting the trolley arm which will work as readily in dense fog as when the wire can be seen. It dispenses altogether with the "fishing rod."

Leeds.—It is expected that electric tramcars will run from Briggate to the New Inn, Wortley, and Whingate, within a few days. The road under the railway bridge in Wellington Road has been lowered, and the electrical equipment of the route is nearly finished.

Levenshulme.—The U.D.C. has approved of the agreement with the Manchester Corporation with reference to the purchase, reconstruction and leasing of the tramways, and has sanctioned the proposal to borrow a sum not exceeding £13,000 for the purpose of carrying it out.

Limerick.—The *Dublin Gazette* announces that the Lord Lieutenant has fixed January 9th next for the hearing of an application for an Order in Council to authorise the construction, maintenance and working of the tramways proposed to be laid in the city of Limerick, and to confirm the resolutions of the Council of the County Borough of Limerick with respect to said tramways.

Liverpool.—The Traffic Sub-committee have under consideration a proposal made by Alderman Salvidge that an all-night service be maintained on the north and south route, a car to run every hour.

Manchester Underground Railway.—The promoters of the proposed Manchester City Circle Railway have deposited their Bill for the next session. A company is proposed to be incorporated, with a share and loan capital of £1,600,000, for the purpose of constructing a circular underground railway in Manchester of an aggregate length of 2 miles 3 furlongs 4 chains. The promoters named in the Bill are Mr. Henry Fishwick, Mr. Frederick John Davis, and Mr. Frederick Jones, who together will form the first directors of the company. The *Manchester Guardian* says that the railway, if sanctioned, is intended to be constructed by means of metal shields driven forward by hydraulic pressure as the work proceeds, and, except in the stations, the internal diameter of the tunnel is not to exceed 12 ft. The time sought within which to construct the railway is seven years from the passing of the Act, during which period it is proposed to pay interest out of capital.

Middlesex.—The Middlesex County Council has decided to enter into an agreement with the Metropolitan Tramways and Omnibus Company in relation to tramways and light railways. The company is to purchase from the North Metropolitan Tramways Company the lines owned by it in Middlesex, and such lines will be worked by the company in connection with the light railways belonging to the County Council. The profits derived from the purchased tramways will be appropriated in the payment of interest at the rate of 6½ per cent. on the expenditure incurred by the company in the purchase and conversion of the lines to electric traction, whilst the balance of the net profits will be divided between the County Council and the company in the proportion of 45 per cent. to the former, and 55 per cent. to the company. A financial paper says that the company will take a lease of several of the County Council's light railways, and in consideration of the payment of 45 per cent. of the net profits on the above-mentioned tramways, the lease of the light railways will be extended to 1930, instead of 1925, as was originally proposed.

Mitcham.—From the printed minutes of the Croydon R.D.C. it appears that a special committee meeting was held on December 5th to consider further the proposals of the B.E.T. Co. After a brief discussion in open Council, it was resolved to defer consideration of the offer, the company meanwhile to be informed that the Council is prepared to negotiate. The Council also decided to instruct Parliamentary agents to oppose for *locus standi* purposes the Bills of the B.E.T. Co., L.U.T., and Brighton Electric Railway.

Oldham.—The borough surveyor has presented a report to the Tramways Committee on the progress of the work on the electric tramways. At all sections the second track has been commenced. Seeing the anxiety of the Committee to be able to open the single line of tramway so as to meet the public convenience, Mr. Hewitt (of Messrs. Hewitt & Rhodes, consulting engineers) proceeded to London to see Col. Von Donop and get to know whether the Board of Trade would allow the running of a single line. The matter was put clearly before the Colonel, who stated that he had never had an application of that kind before him from any Corporation, but was willing to allow it to be done in that case providing that proper facilities were given for the entrance and exit of passengers, and that no pitfalls were left when the other line was constructed which would be dangerous to intending passengers. It was only on the understanding that it would be beneficial to the general public of Oldham that he would give his consent, and he seemed rather interested in such an experiment being tried. When examining the line it was thought it would be impossible to run beyond Werneth (from the borough boundary) into the centre of the town, owing to the number of crossings. Messrs. Hewitt and Rhodes reported that the material for the overhead and underground work was all delivered and ready for erection. They were waiting for the poles to be completed, and also for the completion of the permanent way. The Committee instructed the borough surveyor to proceed with the laying of one line, and the question of running on a single track was left over for further consideration.

A meeting of shopkeepers has been held, at which a resolution was passed objecting to tramways being constructed with a less space than 9 ft. 6 in. between the outside of the footpath and the nearest rail. Altogether there are 11 different parts of the various routes on which it is proposed to lay double tracks and allow less than the above-mentioned space. A resolution was also passed strongly protesting against the manner in which the shopkeepers' interests are being seriously injured by the slow progress being made with the construction of the tramways.

Paris Underground Railways.—It is reported that the City of Paris proposes to borrow £6,000,000 at 3½ per cent. for the extension of the underground electric metropolitan railway system.

St. Helens.—The directors of the St. Helens Tramway Company have for some time been endeavouring to arrange with the Corporation that goods may be carried over the tramways. The Council is to be asked to agree to a rent of 2d. per truck being paid for every car passing through the borough and 1d. for every car, laden or empty, passing certain points. From the date when goods begin to be carried the company will not be entitled to obtain electricity at 1d. per unit on consuming 800,000 units, but the minimum will be 1,000,000 units. The goods traffic will have to be worked conveniently for the Corporation as regards the use of electricity.

South Lancashire.—The work of constructing the South Lancashire tramways is now being carried on vigorously. The contracts for ways and equipment of Haydock, Brough, Ashton and Abram; Hindley to Hindley Green, Atherton to Bolton, Atherton to Tyldesley and Leigh, have been placed, the sum of them being £350,415. The tramways which are about to be constructed will have a total length of 133 miles. This, however, is not the entire length of tramways contemplated under the South Lancashire scheme. Other lengths will be proceeded with later.

Southampton.—The Tramways Committee recommended the transfer of the whole of the electrical equipment to the Electricity Committee, and that of the maintenance of the present lines and the construction of new lines to the Works Committee, under the superintendence of the electrical engineer and the borough engineer respectively.

It has been resolved not to make an appointment to the position of tramways manager at present.

Sutton.—The U.D.C. and the B.E.T. Co. have arrived at the following heads of agreement:—

1. The company to obtain tramway powers, but certain lines not to be proceeded with without the Council's consent, nor is the Council to be prejudiced in their option to purchase certain land and the electric lighting works.
2. The company to widen specified roadways (but without being compelled to purchase land for these purposes); to make up and drain the same; all disputes being referred to the Board of Trade.
4. The company to submit plant and give notices in the usual way.
5. The company to pave the track with granite setts, as may be agreed; or settled by the Board of Trade.
6. Certain roadways to be wood paved the whole width by the company.
7. The company to maintain the roadway under Sec. 28 of the Act of 1870, or to contract for the same with the Council.
8. All standards and overhead work to be approved by the Council.
9. The Council to have the option of fixing electric lamps to the company's standard.
10. The usual provisions as to bye-laws.
11. A clause of the Bill to relate to "cheap fares" for workmen at a minimum fare of 1d.
12. The Council to have the option of purchasing at "fair market value" in 42 years so much of the undertaking as is in the district.

The Committee have yet to report upon the question of double or single track and crossing places.

Sunbury.—The U.D.C. having considered the terms of the L.U.T. extension scheme, have resolved to require a number of amendments to the order, of which the following are the chief:—

1. Double lines not to be changed to single.
2. Staines Road to be 45 ft. wide and Hanworth Road 36 ft.
3. Track to be wood-paved, and roads made up and metalled.
4. New footways to be made up, or old ones widened, when desired.
5. Road drainage to be satisfactory.
6. Company to maintain the whole roadway along which trams run.
7. Brackets to be fixed to houses, where necessary, instead of iron standards.
8. Company to light route by electricity.

Tyneside.—The Tyneside Tramways and Tramroads Company who are at present engaged in constructing lines between Gosforth, Wallsend, and North Shields, are applying this session for power to construct further routes. The company are promoting in Gosforth lines from Gosforth Station across the North Road to Statters Road and thence by a loop line through Coxlodge and down Jubilee Land. Another of their proposed lines runs from Gosforth

up the North Road through Gosforth Park and thence the growing districts of West Moor, Clousden Hill, Forest Hall and Benton, join the companies authorised tramroad near Gosforth Row. These lines are, wherever possible, laid on private property, or off the carriageway of the road, with the object of securing at a moderate price a satisfactory form of permanent way construction and the ability to run at a higher speed than would be permissible if the track occupied the same position on the road as the ordinary vehicular traffic. The aggregate length of the routes proposed is about 11 miles, and the lines are laid out so as to communicate with or give easy access to the existing system of the Newcastle-on-Tyne Corporation and the Tynemouth and Whiteley Tramways.

Wigan.—At the T.C. on Monday, when the minutes of the Tramways Sub-committee came up for confirmation, Mr. Councillor Woods moved an amendment against the Council withdrawing from the negotiations for the purchase of the undertaking of the Wigan and District Tramways Company, and urged that, in accordance with pledges given to municipalise the tramways, the negotiations should be continued. He understood that there was only a difference of £5,000 involved. It was to the interests of the borough that the negotiations should be continued. After some discussion, the amendment was lost.

Wolverhampton. — On Christmas Eve what was described as an official trial of a Lorain surface contact tramcar at the car depôt, Cleveland Road, took place in the presence of the members of the Corporation and a number of officials. In reality what took place was a test of a portion of the experimental mile track. The company assembled inspected the new depôt and the cars, together with various portions of the Lorain equipment. The car having been prepared it was soon crowded with a number of the party and run out of the depôt in fine style. Unfortunately it overran the points when reversing, and the passengers had to get out while the car was hauled back on to the rails. This, however, was the only mishap, the car otherwise performing very well; and the party and a number of the general public enjoyed trips down to workhouse and back. Our local correspondent says that, in spite of the sloppy state of the road, the car ran with great smoothness, and was in admirable control.

Woodford.—The D.C. is to obtain expert advice regarding the proposal of the Walthamstow U.D.C. to construct light railways which shall run in the Woodford district.

Wallington.—To-day (Friday) a public meeting will be held, or called by the Parish Council, to consider the question of opposing tramways.

West Bromwich.—The Highways Committee of the Corporation have issued a report respecting the transfer of the tramways to the Corporation. The Committee recommend, therefore, that the treasurer be empowered to draw a cheque for £32,000 for the purchase of the South Staffordshire tramways within the borough, and for a sum not exceeding £650 for compensation for loss of rent, and a cheque for £5,500 for the purchase of the Birmingham and Midland tramways within the borough. In November last the Council approved and adopted a system of reconstruction and electrical equipment of the tramways, and the Committee recommend that application be made to the Board of Trade for sanction to borrow £121,000 to carry out the reconstruction and electrical equipment, and for their approval of the plans and details and method of traction. The report was discussed at a meeting of the T.C. on Monday, and the recommendations were unanimously approved.

TELEGRAPH AND TELEPHONE NOTES.

American Telegraphs.—It is said that President Roosevelt has come forward as an advocate of Government ownership of telegraphs, and he intends to try to induce Congress to pass a law taking over the control of the private companies now operating in the United States.

The Censorship on Telegrams.—The Postmaster-General has notified a further relaxation in the censorship arrangements by the addition of the "Unicode" to the list of codes authorised for use in telegrams to Cape Colony, Natal, Rhodesia, Zanzibar, Seychelles, Mauritius, Madagascar, British East Africa, German East Africa, Mozambique, Lorenzo Marques.

Durban Telephones.—The Town Council has resolved to intimate to the Telephone Company that it intends to take over the service at the expiration of three months' notice and to municipalise the system.

Portsmouth Telephones.—The L.G.B. has sanctioned the borrowing of money for a municipal telephone service.

Salford Telephones.—Ratepayers met under the presidency of the Mayor on 23rd ult. and declined to pass a resolution proposed by the Mayor consenting to the promotion of the Manchester Telephone Exchange Area Bill. The resolution was defeated by a large majority, after which Alderman Holland demanded a poll. The meeting also agreed to the promotion of a Bill enabling the Corporation to make and maintain additional tramways in the borough. It was stated that they had not yet come to terms with Manchester for running powers, they failing to agree on the matter of price.

Telegraphic Interruptions and Repairs :—

	Interrupted.	Repaired.
Cables.		
Latakia-Cyprus	June 20, 1899	
Para-Maranham	March 1, 1900	
Trinidad-Demerara	Dec. 12, 1901	Dec. 30.
Anjer-Kalianda	Dec. 17, 1901	Dec. 29.
Mole St. Nicholas-Port au Prince	Dec. 28, 1901	
Landlines :—		
"*Via* Hanekin" on Persian territory	Feb. 24, 1900	
Communication with Baranquilla and Cartagena	Dec. 8, 1900	
Majunga-Tanarive	Dec. 15, 1901	
Venezuelan Government landlines	Dec. 22, 1901	Dec. 24.
Cap Haitien-Port au Prince	Dec. 31, 1901	

Turkish Telegraphs.—The *Levant Herald* states that the telegraph line which is to connect the Yemen system with the Selt-Mecca line has been completed as far as Djizan, a distance of 103 miles from Lehieh, the starting point.

Underground Telegraphs.—The following is a copy of the communication sent by the Secretary to the Post Office to the London Chamber of Commerce on the 29th ult. in reply to their recently published letter respecting the interruption of telegraphic communication caused by the storm :—

I am directed by the Postmaster-General to acknowledge the receipt of your letter of the 18th inst., on the subject of telegraphic interruption through storms and other natural causes, and to request you to convey the following information to the London Chamber of Commerce. On March 7th last, the Postmaster-General informed the Association of Chambers of Commerce of the United Kingdom that much had been done in recent years to provide against interruptions and to give stability to the service; the principal lines had been renewed with stouter timber; a large number of reserve wires had been provided on alternative routes in areas liable to storm damage; and an important experimental underground telegraph line to Birmingham had been constructed. He used the word "experimental" because there were drawbacks to the use of the line, as, for example, the necessity to take two wires to form a circuit for certain methods of telegraphy where one wire would suffice on an aerial line; and there were several electrical problems which had to be solved before it could be said that the line was successful. He explained that until recently the great cost of gutta-percha covered wire, and its electrical defects, had stood in the way of the construction of long underground lines, and that it was only the introduction of paper-insulated cable—a material better from an electrical point of view, and cheaper than gutta-percha wire—which had justified the Department in undertaking the construction of the line to Birmingham. He added that the result of the experiment in this case, although leaving something to be desired, was sufficiently encouraging to justify him in proceeding with the extension of the system, although it was still necessary to proceed with caution. The fact, however, remains that underground lines are not fitted to afford efficient telephonic communication between distant towns. The Postmaster-General proceeded to act in the manner indicated in his reply to the Association, and the construction of an extension of the London-Birmingham underground line to Stafford was undertaken without delay. At the same time an underground line was begun from Preston northwards in a district of the country where the aerial lines were much exposed to storms. Owing to financial exigencies it has not been possible to make much progress with the last-mentioned line, but the Postmaster-General hopes to be in a position to proceed with its construction more rapidly during the next financial year. He can hold out no hope that the present aerial system will be replaced by underground wires. The efficient working of the trunk telephones can only be assured by a large use of overground wires, and there are several methods of telegraphy which it would be impossible to work if only underground lines were available. But Lord Londonderry feels as strongly as the Chambers of Commerce that efforts ought to be made to provide underground wires for telegraph purposes, by way of supplement to the aerial lines, and to prevent a total interruption of communication between the principal towns. The initial difficulties having now to a large extent been overcome, the question becomes principally one of money; and it will be obvious that, in view of the present condition of the National Finance, it will be impossible for this department in the immediate future to undertake any large capital expenditure, such as would be required in order to carry out a complete scheme of underground wires. The London Chamber of Commerce may feel assured, however, that the Postmaster-General will continue to give the matter his most earnest attention, and that he will extend the underground system as far as it is possible for him to do so. The area of country most subject to disturbance from gales is that lying between the Bristol Channel and the Wash; and the Postmaster-General had reason to think that in constructing a line from London to Birmingham he was giving stability to the communications, not merely of these two cities, but also of the whole country. The recent interruption, I am to explain, was caused, not by wind alone, but by snow, falling at a temperature which caused it to cling to and accumulate on the wires, where it froze and added so largely to the weight as to drag the poles out of the ground.

Wireless Telegraphy.—In the course of his annual statement on the year's operations of the Mersey Docks and Harbour Board, on Thursday of last week, the chairman of the Board, Mr. R. Gladstone, said that the wireless system of telegraphy was under consideration by the Marine Committee with reference to their lightships. He hoped it would not be long before they had the wireless telegraph on their lightships, and perhaps on their lighthouses also.

At a recent meeting of the Launceston Chamber of Commerce, a motion was passed requesting the Postmaster-General to make a careful investigation into the system of wireless telegraphy and the prospects of its utility between Tasmania and the mainland. The chairman stated that Lloyd's had been granted permission by the Government to establish at their own expense wireless telegraphy between Tasmania and Snow Island, and it was now proposed to extend the system to King Island.

The *Times* correspondent at Ottawa says that Mr. Marconi is greatly impressed with the suitability of Sable Island as a site for a station from which to communicate with Cornwall.

It is reported that Japan has begun to erect wireless telegraph stations on the Korean coast.

Another despatch says that the Korean Government has decided to grant permission to the Japanese Government to lay a cable, and also to establish a wireless telegraph service between Fusan and Chemulpo.

CONTRACTS OPEN AND CLOSED.

OPEN.

Barking Town.—January 24th. Additional generating plant for the Council's electricity works. See "Official Notices" December 20th.

Barnstaple.—January 16th. Boilers, engines, dynamos, mains, &c., for the Town Council. See "Official Notices" December 13th.

Belfast.—January 17th. Cables, roadwork, conduits, &c., for the Electrical Committee. See "Official Notices" to-day.

Belgium.—February 15th. Proposals are being invited by the municipal authorities of Lourain for the lighting of the public streets by electricity or gas.

Belgium.—March 1st. The municipal authorities of Ghent are inviting tenders until the March 1st, 1902, for the concession for an electric lighting installation. See our "Official Notices" to-day.

Bournemouth.—January 6th. Feeder cables, pilot and arc lighting cables, and conduits, for the Corporation tramways. See "Official Notices" December 20th.

Egypt.—January 18th. Electric lighting of Suez and Damanhour. Particulars from the Minister of Public Works, Cairo.

Grimsby.—January 20th. Steam dynamos, switchboard extensions, battery, condenser, piping, water-tube boiler for electricity works. See "Official Notices" December 27th.

Hartlepool.—January 25th. Buildings, marine boilers, engines and dynamos, battery, switchboard, arc lamps, columns, mains, and cranes, for electricity supply works for the Corporation. See "Official Notices" to-day.

Hornsey.—January 15th. Pipework and mechanical coal-handling plant for electricity works for the U.D.C. See "Official Notices" December 6th.

Hunslet.—January 21st. Electrical equipment of the new workhouse and infirmary at Bothwell Haigh for the Guardians. See "Official Notices" to-day.

Kirkcaldy.—January 8th. Piping, pumps, feed heater, &c., for electricity works. See "Official Notices" December 13th.

L.C.C.—January 14th. Electric wiring and fittings for the Council's new Farmfield Reformatory near Horley. See "Official Notices" to-day.

Leeds. — January 16th. Surface condensing plant (2,000 B.H.P.) for the electric lighting department. See "Official Notices" to-day.

Manchester.—January 21st. Three-phase switchboards, exciter and auxiliary ditto, three-phase boards for sub-stations, low tension boards at sub-stations at the Stuart Street generating station. See "Official Notices" December 20th.

Middlesbrough.—January 21st. 300-KW. engine and dynamo, switchboard panels, ejector condenser, feed pump and economiser for the electricity works. See "Official Notices" December 20th.

Nantwich.—January 6th. Water-tube and Lancashire boilers, steam dynamos, pumps and piping, switchboard, mains, posts, battery, meters, crane and dust destructor for the U.D.C. See "Official Notices" November 22nd.

Paisley. — January 13th. Steam engines, dyamos, switchboards, and condensers, for electric tramway station. See "Official Notices" to-day.

Poplar.—January 11th. Electric lighting of the Town Hall, and Bow and Bromley Vestry Halls. See "Official Notices" to-day.

Rockhampton (Australia).—March 31st. We read in the *Contract Journal* that the Council of the Municipality of Rockhampton is prepared to consider applications from companies desirous of undertaking the construction and working of a system of electric tramways under the Queensland Tramways Act of 1882, and the Amendment Act of 1890. Rockhampton with a population of 15,461, is a rising town, and is situated on the Fitzroy River, about 40 miles from the sea coast, and is the second largest town in Queensland. Particulars of construction, maintenance, and working of tramways are contained in the Queensland Tramways Act of 1882, and the Amendment Act of 1890, copies of which may be seen at the office of our contemporary. Applications to be forwarded to Mr. H. W. Johnson, Mayor, Municipal Chambers, Rockhampton, Queensland, Australia, by March 31st.

Stepney. — January 9th. Hire purchase or assisted wiring proposals are wanted by the Borough Council. See "Official Notices" December 27th.

St. Pancras.—January 17th. Engines, dynamos, condensers, piping, boilers, pumps, &c., for the Borough Council. See "Official Notices" to-day.

Spain.—January 27th. Tenders are being invited by the Spanish Ministry of Public Works in Madrid until the 27th inst., for the concession for the construction and working of an electric tramway between Tolosa and San Sebastian (Guipuzcoa province). Tenders are to be sent to El Ministerio de Obras Publicas, Madrid, whence particulars may be obtained.

Spain.—The Spanish Prison authorities have just called for tenders for an electric lighting installation in the prison in Madrid, and the working of the same during a period of 15 years.

Warrington.—January 4th. Tramway shop equipment and switchboard extensions for the Corporation. See "Official Notices" December 20th.

West Bromwich.—January 17th. Rails, points, crossings, drain rails, road work, bonding, trolley poles, overhead line work, section boxes, cables, &c., for electric tramways for the Council. See "Official Notices" December 20th.

West Ham.—January 14th. Surface condensing plant and travelling crane for the electricity works. See "Official Notices" December 13th.

West Hartlepool.—January 6th. Iron and steel bars, bolts, &c., also engine room and other stores and sundries for the electric lighting department. See "Official Notices" to-day.

CLOSED.

Cheshire.—A portion of the St. Helens Cable Company's tender for india-rubber goods has been accepted by the Cheshire Lines Committee for 1902.

East Ham.—The T.C. has referred the tenders for wiring the new municipal buildings to the Chairman and several members, with power to accept a tender.

Huddersfield.— We understand that Messrs. Fairbairn Lawson Combe Barbour, Limited, of 52, Lime Street, London, have secured an order from the Huddersfield Corporation for a vertical compound tramway generator engine of 1,300 I.H.P.

Kirkcaldy.—The T.C. has accepted the following tenders for the new tramway works in the burgh:—British Insulated Wire Company, Limited, for overhead construction, £3,487; Improved Glow Lamp Company, for arc lamp-posts, £453; and Cox-Walkers, Limited, for switchboard and motor-generators, £2,746.

London.—For the supply and delivery of one 1,000-ampere electro-typing dynamo, direct-coupled to 400-volt enclosed motor, for the Celvicol Company, Limited, S.E.

Crompton & Co., Limited	£190 0 0
Collis & Sons	165 0 0
General Electric Company	150 0 0
Baxter & Caunter (Newton Electrical Works), *accepted*	130 0 0

For the supply and fixing of one 20 cwt. electric goods lift for the same company:—

The Otis Elevator Company	£428 0 0
R. Waygood & Co. *accepted*	335 0 0
J. G. Childs & Co.	335 0 0
F. A. Glover & Co.	333 0 0
M. T. Medway	332 0 0
Moffatt & Eastmead	308 15 6

Consulting Engineer, B. H. Jenkinson, Crouch End, N.

Mersey Railway.—A contract for the supply of about 60 cars for the Mersey railway, which is about to be electrified by the Westinghouse Company, has been entered into by Messrs. G. F. Milnes & Co., Birkenhead. The value of the cars is £40,000. Each car will be 60 ft. long and will accommodate about 70 persons. The bottoms of the cars, above the motors, are to be sheeted with asbestos as a protection against ignition in the event of any fusing. The cars will be protected generally against fire by the use of fireproof materials. They will be made at Hadley.

Middleton.—The contract for wiring and fitting the electric lighting and tramway station has been given to Mr. R. S. Blackburn, of Hebden Bridge.

Skipton.— The Fire Brigade Committee have decided upon the contracts for the fire alarm calls and the tender sent in by Mr. R. S. Blackburn, of Hebden Bridge, has been accepted. The installation will consist of the Blackburn patent electric and steam fire alarm system.

FORTHCOMING EVENTS.

Friday, January 3rd.—At 8 p.m. Institution of Junior Engineers. Westminster Palace Hotel. Paper to be read and discussed, "The Uses of Exhaust Steam," by Mr. John Buley, of London.

Thursday, January 9th.—At 8 p.m. Institution of Electrical Engineers. Meeting at the Institution of Civil Engineers, Great George Street, Westminster, S.W. Discussion of the Technical Reports on the Institution visit to Germany, 1901, by the Committees on Traction, Light and Power; Manufacturing; and Telegraphs and Telephones.

Tuesday, January 14th.—At 7.30 p.m. Institution of Electrical Engineers (Manchester Section). Meeting at Owens College; paper on "Electric Furnaces," by Bertram Blount.

At 8 p.m. Institution of Electrical Engineers (Glasgow Section). Meeting at the Institution of Engineers and Shipbuilders, 207, Bath Street.

At 8 p.m. Institution of Civil Engineers. Meeting. Paper to be submitted for discussion: "American Workshop Methods in Steel Construction," by H. B. Molesworth.

Wednesday, January 15th.—At 7.30 p.m. Institution of Electrical Engineers (Birmingham Section). Meeting in the Physical Theatre of the University.

NOTES.

The London Telephone Service.—The conference of the London local authorities, held at the Guildhall on December 23rd to consider the newly ordained telephone rates was a very unanimous assembly. The Lord Mayor, who opened the proceedings, impressed upon the delegates the importance of carrying on their deliberations without the slightest sign of party politics, and thereupon Mr. A. C. Morton was elected to the chair. The idea that party politics, in the ordinary sense, has any bearing on telephone discussions is somewhat amusing. When the City Corporation and the London County Council are of one mind, when the newly-elected mayors of the newly-formed boroughs speak with one voice, there must be a considerable repression of personal predilection, and a strong sentiment in favour of the object sought. Such a conference as that held ought to be really representative of local government, and should carry weight. We regret very much that so representative an assembly, meeting in the official hall of the greatest city in the world, should have approached such a subject with so little commercial acumen, with so much *ex parte* statement, and so little deliberation. Mr. Morton's interest in the telephone question is well known, as are his efforts at cheapening the service through the powers of the City Corporation. Mr. Benn has also taken a leading part on the County Council in the effort to "popularise" the telephone. But when the question is asked as to what the representatives of the local authorities have done to afford facilities for the extension of telephone service it is found that their attitude has been rather to obstruct than otherwise. The City Corporation refused permission to use existing pipes unless the rate were reduced to £8 per annum. The County Council made preliminary arrangements for granting underground facilities and then refused them. Now, we see no reason to doubt that the attitude of both these bodies and the prominent individuals therein is guided by the best intentions for Londoners and their telephones, but for serious organisations they seem to be singularly averse to acquiring accurate information. It may be said without any reserve that so long as it cost a minimum sum of £20 a year to call or be called by telephone, there was little chance of the service becoming "popular," but with the introduction of a message-rate system, and a minimum payment of £6 10s. per annum, the sting of exclusiveness has been removed, and one is inclined to doubt the genuineness of an agitation which aims at an unlimited user for a nominal sum. If the prominent people really understood what unlimited user meant, they would be among the first to complain that the well-to-do people who could well afford to pay according to use, were receiving benefits for which the less affluent, smaller users, had to pay. The proposal to base the charges on the capital expenditure, quoted by Mr. Hanbury in 1899, seems a little absurd, since in the intervening period the Post Office Department has acquired actual experience of capital expenditure.

The Nernst Lamp.—The *Financial Times* says:—"The German Patent Office has just arrived at an important decision which affects the future of the Nernst electric lamp, and which is of considerable interest to lampmakers in England. At present the Nernst patents for Germany are held by the Allgemeine Elektricitäts Gesellschaft, of Berlin, and Herr Wilhelm Boehm, a chemist of that city, sought to test the validity of Patent No. 104,872, granted for a method of producing an electrical incandescent light. The result has been that the Patent Office has declared this particular patent to be invalid. In announcing its intention to appeal to the Reichs Gericht against this decision, the company states that the Nernst lamp is controlled by 14 patents, of which one is now alleged to be of no value. This patent, the company remarks, only concerns a contrivance for the preliminary heating of the illuminating materials, and the judgment of the Patent Office will not affect the manufacture of the lamp. On the other hand, Herr Boehm replies that the patent declared invalid is the 'actual Nernst patent,' which has hitherto prevented other persons from making any progress in consequence of the monopoly held concerning the means of heating the illuminating material."

Civil and Mechanical Engineers' Society.—Before this Society at Westminster yesterday, Thursday evening, a paper on "Engineering Observations in 1901 in the United States of America," was read by Mr. A. S. E. Ackermann, A.M.I.C.E.

Personal.—Mr. Alfred H. Gibbings, having accepted the appointment of resident electrical engineer to the Hyde, Stalybridge, Dukinfield and Mossley joint board, has entirely relinquished consulting practice in order to devote the whole of his time to the work he has undertaken. He is, therefore, retiring from the firm of Messrs. Gibbings & Baker, in which he will be succeeded by Mr. H. W. Appleby, who has taken an active share in the business for some time.

Mr. E. H. Mottram, manager of the Poole and District Electric Traction Company, was last week presented with a set of carvers, as a mark of respect and esteem by the tram motor men and conductors.

Mr. J. W. Lincoln, who is chief draughtsman in the Sunderland Corporation Electric Supply Works, has obtained an appointment under the British Electric Traction Company, Limited. He joins Mr. H. E. Prescott, the construction engineer.

The Leicester T.C. on Tuesday voted £500 to Mr. Mawbey, the borough surveyor, as an honorarium for his services in connection with the electric tramway project, and increased his salary from £1,000 to £1,250 per annum.

Travelling Crane.—Referring to the travelling jib crane illustrated on p. 1005 in our issue of December 13th, Messrs. Royce, Limited, draw our attention to the fact that the whole of the crane portion, together with the controlling gear and flexible connections, were designed and supplied by themselves; the carriage upon which the crane is mounted and the woodwork of the cabin were supplied by the purchasers.

Horse Killed.—A carriage drawn by two valuable horses was crossing the private gravelled carriage way of Mr. Corbett Woodall's house in Fitzjohn's Avenue, Hampstead, London, when one of the horses was killed and the other horse slightly injured. We understand from Mr. Cottam that there was a slight leakage from a private lead which was supplying an outside lamp at the house in question. No doubt one of the horses felt this and became restive, but its death was caused by falling down and being trampled upon and kicked by the other.

Institution of Electrical Engineers (Cape Town).—At the December meeting a paper was read by Mr. J. Denham on "Electrical Engineering: from a Tour to Europe and America." The meeting was held in the hall of the South African College.

Royal Institution.—The course of Christmas lectures was commenced last Saturday by Dr. J. A. Fleming on "Waves and Ripples in Water, Air, and Ether." The second lecture was delivered on Tuesday.

Fatalities.—On Christmas Day two men were suffocated and two others partially overcome by gas fumes, while engaged in making alterations to a gasometer at the works of the Chloride Electrical Storage Syndicate at Clifton Junction.

Obituary.—We learn with regret that Mr. John Neale died at his residence, Wychdon Villa, Hixon, near Stafford, on December 18th, after a brief illness. Mr. Neale was 68 years of age. He joined the service of the Electric and International Telegraph Company in 1851 at the Strand office; at Stafford 1852; at Manchester 1853; and Birmingham 1854. In 1859 he was appointed Inspector in charge of the North Staffordshire and London and North-Western lines in the Midland Counties. In 1870 on the transfer of the telegraphs to the Government, he was appointed Telegraph Superintendent and Electrical Engineer to the North Staffordshire Railway Company, which position he held up to the time of his death. In 1873 he patented the acoustic single-needle dial which is now used by the Post Office and railways; and a single wire block instrument which is now in use on the North Staffordshire Railway; also a recording block instrument for permissive block use, showing the number of trains actually in the section; and a rail treadle so that trains can announce their approach at level crossings automatically. Mr. Neale also acted as honorary secretary to the Conference of Railway Telegraph Engineers and Superintendents at their half-yearly meetings. The funeral took place at Hixon Church on December 21st.

Warning.—Messrs. J. C. Lyell & Co., of 53, Victoria Street, S.W., ask us to publish the following:—"We find that some unauthorised collector has been going round to our clients to collect accounts. We are at present unable to trace out who this is, but shall be obliged if your readers will kindly note that all our authorised collectors are provided with printed numbered receipts, and should anyone call purporting to be one of our collectors and not be able to produce a receipt form, the police should be immediately communicated with.—*p.p.* J. C. Lyell & Co."

The Nervous System.—The Chicago correspondent of the *Standard* sends the following despatch:—"Prof. Loeb, of the University of Chicago, announces to the American Physiological Society the discovery of a method of nerve action which goes far towards solving the mystery of life itself. Prof. Loeb's announcement is expressed in 14 statements couched in scientific terms, both new and otherwise indefinite, and hence unintelligible to the laity if stated in his language. Reduced to less difficult phraseology, the statement says that the nerves contain, or consist of, a colloidal solution, whose particles carry positive electric charges. The solution resembles jelly before it "jells." Nerve action is simply the passage to and from conditions of gelatification and solution through electrical discharges between the colloidal particles. Negative ions, termed anions, may have several negative charges. Chemicals positively charged with sodium or potassium maintain the colloidal solution of the nerves. Whenever negative charges are in excess the nerve tends towards gelatification. Hence nervous irritability is lessened by whatever increases the condition of solution, and is increased by whatever promotes gelatification. Heat promotes gelatification and nerve stimulation, while cold makes solution less stable. Nerves are stimulated also mechanically, because when colloidal particles coalesce, as drops melt together, electrical discharges are caused. Nerve-colloids are largely fat compounds soluble in ether. Hence anæsthetics lessen nerve irritability by increasing the permanency of colloidal solution and preventing gelatification. The phenomenon of drunkenness is similarly explained. From the electro-magnetic theory of light it follows that chemical stimulation is identical with stimulation by light waves, and the stimulating action of any anion increases as its spectrum approaches ultra violet. Long light waves and heat waves act like positively charged ions. The explanation of the beating of the heart is the gelatification of its contained colloids. The function is electric in character, and controlled by chemical action governed by associated bodily functions now reducible to formulæ, *i.e.*, phenomena of life have a mathematic basis analogous to the mathematics of chemistry. How far Prof. Loeb can go is a mystery. He has indefinitely postponed the death of sea-urchin eggs by potassium cyanide solutions, according to the theory outlined. New York scientists agree with Prof. Loeb that the nervous theory resulting from the investigations of himself and his collaborator, Dr. Albert Matthews—to whom Prof. Loeb awards the first place in this connection—is the most important fundamental physiological generalisation made within 50 years. Both inquirers are authorities in this branch of science, to which each has made important analogous contributions. Dr. Matthews studied with Prof. Kossels at Heidelberg."

Appointments Vacant.—A chief engineer is wanted for Canterbury electricity works, at £250 per annum; a traffic assistant at £120 is required for Huddersfield tramways department; an assistant, with experience in the overhead equipment of tramways, is wanted for Southend; clerk of works for Willesden electricity works at £3 3s. per week.

Stirling Street Lighting.—The advent of the New Year was celebrated in Stirling by the switching on of an extension of street lighting, consisting of 30 8-ampere Brockie-Pell arc lamps. The lighting effect is exceedingly good, and completely puts in the shade the incandescent gas lamps, which used to light one of the streets, and now serve as a very good object lesson. The whole of the cable—about 6,000 yards—was laid and the posts erected by the town's workmen, under the supervision of the burgh electrical engineer, Mr. A. C. Hanson.

Electric Power Transmission in British Columbia.—A large electric power transmission system is now being put down for the supply of lighting and power to the various mining towns and settlements in the neighbourhood of Cascade, Phœnix, and Greenwood, B.C. The London and British Columbia Gold Fields Company control the undertaking through a subsidiary concern known as the Kettle River Power Company. The power supply is to be drawn from the Kettle River at Cascade, where the river rushes through a rocky gorge in a series of rapids for a distance of about half a mile. The fall over this length is over 121 ft. A dam built at the head of the gorge raises the level of the river by 36 ft., and thus gives a total available working head of about 156 ft. at low water. The dam is a large structure of timber crib-work filled in with rock; it is 400 ft. long, and varies in height from 50 ft. at the centre of the stream to 25 ft. at the banks. The river bed is of solid rock, into which the dam foundation timbers are securely bolted. Twelve sluice ways are built in the dam to control the level of the water during times of flood. They give a total waterway area of 2,000 sq. ft. The sluice ways are closed by 12 in. × 12 in. timber logs dropped into position one above another. The logs are raised by a winch driven either by hand or electric motor. The winch is carried on a traverser which runs on a steel rail track laid along the top of the dam. During the river floods of last June an unexpected and most severe test was put upon the dam. A large raft of lumber, belonging to a local company, broke away from a point a few hundred yards up the stream, and about a million feet of lumber was thrown against the dam in a solid mass. This huge impact made not the slightest impression on the dam. Immediately below the river dam convenient space is left for the building of a masonry dam, should that be found necessary in the future, the construction of which would not interfere with the continuous operation of the present power plant. The water channel between the head of the gorge and the power house is practically all cut out of the solid rock, over 3,500 cubic yards of which have been excavated for this purpose. From the dam the water channel, for 225 ft. of its length, is an open cut in the rock. Afterwards a tunnel 12 ft. × 14 ft. is driven for a distance of 410 ft., followed by another open channel for a distance of 500 ft., complete the connection between the dam and the flume to the power house. The flume is of circular section, 12 ft. in diameter. The open rock channels and the tunnel are sufficiently large to cause no appreciable loss of head, and the water enters the flume with a head equal to the level of the water behind the dam. The power house is built on a site at the foot of the falls, excavated out of the solid rock, some 7,000 yards of which has been taken out for this purpose. It is a fireproof structure, having a length of 200 ft., and a width of 45 ft., built of brick and stone. The generating machinery consists of horizontal type turbines direct coupled to Westinghouse three-phase alternate current generators. Current from these generators is passed through transformers whereby the pressure is stepped up for transmission along overhead conductors. The overhead lines are in duplicate. They are installed on the most substantial and modern principles on a private right of way for the whole distance from Cascade to Phœnix, about 21 miles. The right of way is a clearing through the brush and timber of 132 ft. wide. Success is assured to the venture, since all the power which can be supplied from the works will be taken up for lighting the towns of Phœnix and Greenwood, and in supplying power throughout the districts, and to various surrounding towns for mining and other purposes.

What's in a Name?—An old friend, outwardly in a new guise, has come to us with the inside as of yore. We have on more than one occasion expressed our doubts as to whether the electrical Charivari wished to be taken seriously or in a comic vein. Those doubts are for ever set at rest by Mr. Linley Sambourne's cartoon. These are indeed electrical times in which we live.

The Cape-Australian Cable.—The *Scotia* left the Thames on Wednesday with the last remaining section of the Cape-Australian cable to be laid between Perth and Australia. The vessel is due at Perth early in February, and the cable is expected to be completed and opened for traffic by the end of that month.

THE CENTRAL STATION ENGINEER.

Personal.—On Monday evening, December 23rd, the members of the permanent staff of the Wigan electricity works held their first annual dinner. The occasion was especially taken to mark the opening of the new Whelley tramway route, and as a mark of the respect in which he is held by his staff, Mr. H. COLLINGS BISHOP, the Borough Electrical and Tramway Engineer and Manager was specially invited to preside. After the usual loyal toasts had been duly honoured, Mr. P. T. White proposed the principal toast of the evening, "The Electricity Undertaking and its Engineer." Mr. Bishop, in his reply, commented on the rapid advance of the undertaking, paying a warm tribute to his staff who had, he remarked, loyally seconded his efforts to make everything a success. He thanked them for the very hearty way in which they had received him, and expressed the hope that this, their first annual dinner, would be the forerunner of many happy similar occasions. Mr. Bishop then made, on behalf of his staff, a presentation to Mr. WILLIAM HART, who is leaving to take up an appointment under the Leigh Corporation. A good musical programme was then entered upon. A very enjoyable evening was brought to a close with "God save the King."

Mr. W. E. J. HEENAN, has been appointed temporary electrical engineer to the Southend Corporation. He was formerly chief engineer of the Northampton Electric Light and Power Company, Limited.

At a special meeting of the Southport Tramways Committee last Saturday, Mr. T. J. KENDREW was appointed successor to Mr. R. J. WILTON as manager of the Southport Electric Tramways. Mr. Kendrew has been employed by the Tramways Committee as superintendent of the depôt in Canning Road, and as assistant manager. He came to Southport when the electric tramways were first opened, having been with Messrs. Mather & Platt, Salford, as outside foreman for the motor fitting department. He commences at £150 a year.

NEW COMPANIES REGISTERED.

Speedwell Motor and Engineering Company, Limited (72,216).—This company was registered on December 19th, with a capital of £10,000 in £1 shares, to acquire the business carried on by J. W. H. Dew and H. Dew, as the "Speedwell Electrical Motor Car and Cycle Company, Limited," at 134, Broad Street, 1, Minster Street, 172, Oxford Road, and 106A, King's Road, Reading, and to carry on the business of manufacturers of electrical and other motor vehicles, submarine and other boats, motor and other cycles, automobiles, electrical and other appliances, machinery, &c. The first subscribers (each with one share), are:—F. W. Albury, Parkside, Reading, architect; F. A. Smith, Uralla, Hamilton Road, Reading, engineer; A. C. Major, 9, Eton Square, Reading, surgeon; G. L. Brigham, Mornington, Redlands Road, Reading, tobacco manufacturer; J. A. P. Price, M.D., 124, Castle Street, Reading; B. Petty, Paxton House, Bath Road, Reading, printer; and A. H. Bull, Sherwood House, Bath Road, Reading, draper. Minimum cash subscription 6,000 shares. The number of directors is not to be less than four nor more than nine; the first are Sir G. A. C. Russell, A. H. East, J. P. Petty, J. W. H. Dew, and A. J. Dew; qualification, £100; remuneration, £125 per annum, divisible. Registered office, 134, Broad Street, Reading.

La Compania De Obras Públicas Del Rio De La Plata, Limited (72,190).—This company was registered on December 17th, with a capital of £200,000 in £10 shares, to carry on the business of contractors for railways, harbours, docks, tramways and other public works, mechanical engineers and manufacturers of and dealers in all kinds of plant, machinery, cables

equipment, apparatus and appliances for use in connection with the above or otherwise, and to carry on any business (whether commercial, financial, manufacturing, trading, or otherwise) which may seem capable of being conveniently carried on in connection with the company's objects. The first subscribers (each with one share) are:—W. A. Allerton, 4, Blandfields Street, Nightingale Lane, S.W., book-keeper; J. Scott, 26, Victoria Street, S.W., secretary; H. Bach, 26, Victoria Street, S.W., accountant; W. H. Cocker, 26, Victoria Street, S.W., clerk; T. J. W. Potter, 82, Sarsfield Road, Balham, S.W., clerk; D. Buchan, 68, Fielding Road, Bedford Park, W., secretary; and J. Mayer, Tytingfarm, Guildford, secretary; no initial public issue. The number of directors is not to be less than three nor more than seven; the first are Baron Emile N. d'Erlanger, George Pauling and Charles C. Bowlby; remuneration as fixed by the company.

J. G. Childs & Co., Limited (72,287).—This company was registered on December 27th, with a capital of £20,000 in £1 shares, to take over the business of electrical engineers now carried on by J. G. Childs, at 145, Farringdon Road, London, as J. G. Childs & Co., and to carry on the business of electricians, electrical, and mechanical engineers, manufacturers of and dealers in electrical apparatus, ironfounders, manufacturers of electric lifts and hoisting machinery, smiths, iron and steel converters, hardwaremen, contractors, &c. The first subscribers (each with one share) are:—J. G. Childs, 145, Farringdon Road, E.C., electrical engineer; H. Turnbull, 3, Myddleton Park, Whetstone, N., electrical engineer; W. J. Childs, 52, Cannon Street, E.C., architect; J. R. Weston, Manor House, Redland, Bristol, electrical engineer; T. S. Hill, 5, Ladbroke Road, W., electrical engineer; F. C. Newton, 84, Tollington Park, N., accountant; and R. Weston, 171, Redland Road, Bristol, gentleman. No initial public issue. The number of directors is not to be less than two nor more than seven; the first are J. G. Childs and H. Turnbull, each of whom may retain office so long as he holds 2,000 shares.

H. Lygoe & Son, Limited (72,254).—This company was registered on December 23rd, with a capital of £1,000 in £1 shares, to acquire the business of engineers and cycle builders, and repairers, carried on at 33, Marchmont Street, Russell Square, and elsewhere, as H. Lygoe & Son, to adopt an agreement with H. Lygoe, and H. J. Lygoe, and to carry on the business of electrical and general engineers, cycle and motor car builders, and repairers, &c. The first subscribers (each with one share) are:—C. P. Farlow, 54, Fitzroy Road, N.W., solicitor; C. F. Farlow, 54, Fitzroy Road, N.W., mechanical and electrical engineer; H. Lygoe, 33, Marchmont Street, W.C., engineer; H. J. Lygoe, 33, Marchmont Street, W.C., engineer; W. T. Lygoe, 18, Harpur Street, W.C., engineer; C. S. Lygoe, 2, Cubitt Street, W.C., engineer; and J. W. Lygoe, 22A, Steadman Chambers, Coptic Street, W.C., engineer. No initial public issue. C. P. Farlow and C. F. Farlow are permanent governing directors; special qualification, £200.

Leicestershire and Warwickshire Electric Power Syndicate, Limited (72,274).—This company was registered on December 24th, with a capital of £20,000 in £10 shares, to carry on in Leicestershire and Warwickshire or elsewhere the business of suppliers of electric power for any purposes, to lay down, establish, fix and maintain any generating stations, works, plant, apparatus, machinery, cables, wires, lines, accumulators, pipes, lamps, works and the like, for the supply of electricity or gas in bulk or otherwise, and to carry on the general business of electricians, electrical, mechanical and general engineers, &c. The first subscribers are:—C. Thomson, 69, Pont Street, S.W., 50 shares; Major W. M. Mackenzie, 29, Onslow Square, S.W., 20 shares; Lieut.-Gen. Sir R. H. Sankey, 32, Grosvenor Place, S.W., 50 shares; H. Holloway, Burntwood Grange, Upper Tooting, S.W., contractor, 100 shares; M. Robinson, Overslade, Rugby, engineer, 50 shares; Sir I. Hart, Kt., Ashleigh, Knighton, Leicestershire, 10 shares; and J. F. Johnson, 90, High Cross Street, Leicestershire, builder and contractor, 10 shares. The first directors (to number not less than three nor more than 11) are C. Thomson, Major W. M. Mackenzie, Lieut.-Gen. Sir R. H. Sankey, H. Holloway and M. Robinson; qualification 20 shares. Registered office: 5, Great George Street, Westminster. No initial public issue.

South-West Wireless Telegraph Ship Company, Limited (72,281).—This company was registered on December 24th with a capital of £25,000 in £1 shares, to enter into an agreement with W. M. Walters, and to carry on the business of a telephone, telegraph, electric light, heat and power supply company, and to establish, maintain, control and work any telegraph stations (on the high seas or elsewhere), electric light, heat and power works, telephone exchanges, machinery, plant, &c., necessary or convenient for the purposes of the company. The first subscribers (with one share each) are:—J. R. Haws, 26, Laurel Road, Old Swan, Liverpool, shipowner; J. Price, 15, Alexandra Road, Waterloo, master mariner; F. J. Pilcher, The Glen, Blundellsands, consulting engineer; S. Hendy, 6, Marine Crescent, Waterloo, shipowner; W. M. Walters, Trafalgar Mount, Egremont, master mariner; S. C. Chambers, Mount Grove, Hamilton Road, New Brighton, ship broker; and C. P. Condron, Holden Street, Blundellsands, ship store dealer. Minimum cash subscription 50 per cent. of any shares first offered to the public. The first directors (to number not less than three nor more than seven) are to be nominated by the subscribers; qualification, £100; remuneration as the company may decide.

British Mica Company, Limited (72,187).—This company was registered on December 17th, with a capital of £5,000 in £1 shares (2,000 7 per cent. cumulative preference), to take over the mica business carried on by Sanders, Wake & Co., at 23, Great St. Helens, E.C., and Lebanon Works, Lebanon Road, Wandsworth, S.W., and to carry on the business of mica manufacturers, agents, vendors, and merchants, makers of, dealers in, and agents for micanite, electrical plant, accessories and machinery, makers of mica chimneys, lamp tops and other goods, &c. The first subscribers are:—H. S. Sanders, 23, Great St. Helens, E.C., mica merchant, 200 shares; J. F. Wake, 23, Great St. Helens, E.C., shipbroker, 200 shares; E. H. Luck, Burghty House, Lady Somerset Road, N.W., gentleman, 200 shares; B. B. Wake, Connaught House, Acton Lane, Harlesden, N.W., gentleman, 1 share; F. E. Gavin, 57, Richmond Road, Barnsbury, N., clerk, 1 share; F. A. Goodworth, 23, Siberia Road, Highbury, N., clerk, 1 share; and R. R. Wake, Connaught House, Acton Lane, Harlesden, N.W., cashier, 1 share. Minimum cash subscription, £100 preference shares. The number of directors is not to be less than three nor more than five; the first are H. S. Sanders, and J. N. Wake; qualification, £200; remuneration, £15 each per annum (to be increased according to profits).

Hobbs & Sons, Limited (72,200).—This company was registered on December 18th, with a capital of £15,000 in £10 shares (600 preference), to adopt an agreement with H. E. Hobbs, William A. Hobbs, and A. J. Hobbs, and to carry on the business of boat builders, boat fitters, steam and electric launch builders, motor manufacturers, suppliers of electric and other power for propelling boats, suppliers of electric light, fuel dealers, electrical and general engineers, boat house keepers, provision merchants, &c. The first subscribers (with one share each) are:—H. E. Hobbs, New Street, Henley, boat builder; W. A. Hobbs, The Laurels, St. Andrew's Road, Henley, boat builder; A. J. Hobbs, The Cottage, Henley, boat builder; F. E. Hunter, Ferry Lodge, Wargrave, chartered accountant; E. J. Hobbs, New Street, Henley, boat builder; J. S. Cooper, Henley, solicitor; and A. E. Hobbs, New Street, Henley, boat builder. No initial public issue. The number of directors is not to be less than three nor more than five; the first are W. A. Hobbs, A. J. Hobbs, and F. C. Hunter; qualification, £100; remuneration as fixed by the company.

Electrical Investment Syndicate, Limited (72,297).—This company was registered on December 28th, with a capital of £1,000 in £1 shares, to carry on the business of suppliers of electricity for light, heat, power, or other purposes, electricians, manufacturers of electrical apparatus, financiers, &c. The first subscribers (each with one share) are:—A. M. Forbes, 27, The Chase, Clapham Common, S.W., clerk; L. S. Cook, 32, Hewitt Road, Harringay, N., clerk; A. Kröner, 28, Montague Road, Hornsey, N., clerk; F. P. Carrington, 30, Dalberg Road, Brixton, gentleman; F. C. Taylor, 30, Dalberg Road, Brixton, gentleman; L. C. Brook, 103, Wood Vale, Forest Hill, S.E., clerk; and F. H. Saunders, 22, Lady Somerset Road, N.W., clerk. No initial public issue. The number of directors is not to be less than two nor more than seven; the first are to be appointed by the subscribers; qualification, £10; remuneration, £1 1s. each per board meeting attended, and 5 per cent. of the amount of dividend divisible.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Marconi International Marine Communication Company, Limited (65,759).—This company's annual return was filed on December 13th when 204,056 shares were taken up out of a nominal capital of £350,000 in 350,000 shares of £1 each. 10s. has been called up on each of 99,056 shares, resulting in the receipt of £47,985 10s. £1,542 10s. remains in arrears. 105,000 shares considered as fully paid. No mortgages or charges.

New St. Helens and District Tramways Company, Limited (59,426).—This company's annual return was filed on November 13th, when 15,980 preference, and 9,000 ordinary shares were taken up out of a nominal of £150,000 in 20,000 preference and 10,000 ordinary shares of £5 each. £125,410 has been received, including £510 paid on 1,020 forfeited shares. No mortgages or charges.

Lancashire Electrical Engineering Company, Limited (56,992).—This company's annual return was filed on October 8th, when 1,833 shares were taken up out of a nominal capital of £5,000 in 5,000 shares of £1 each. £1,833 is considered as paid. No mortgages or charges registered.

Sandgate and Hythe Electric Company, Limited (57,997).—This company's annual return was filed on October 14th, when seven shares were taken up out of a nominal capital of £1,000 in 100 shares of £10 each. No calls. No mortgages or charges.

CITY NOTES.

The Metropolitan District Railway Company.

AT a special meeting of the company, held on December 23rd, the Metropolitan District Railway Bill and the Brompton and Piccadilly Circus Railway Bill, shortly to be considered by Parliament, were approved. In the course of his speech Mr. R. W. Perks, M.P., the chairman, covered briefly the history of the negotiations, extending over many years, which led up to the present position of the question of electrification. We quote from his remarks as follows:—The directors of the two companies, supported by the proprietors up to a certain point, determined to ignore the advice given by Sir John Wolfe Barry and Sir William Preece. Sir John Wolfe Barry at his (the chairman's) request, had resumed his old position as consulting engineer of the railway. In addition, as they were working in close unison with the Traction Company, they would have the benefit of that company's consulting engineer, Sir Alexander Binnie. About a year ago they embarked on what he thought he might say, without offence, was a rather wild goose chase. They invited tenders, or suggestions, from a number of well-known firms, some American, some British, and some Continental, all of whom sent in tenders based upon various theories, and varying greatly in amount, and this company partially committed itself to a project submitted by an Austrian firm. A very influential section of the proprietors was against that step. As a result, they had to thresh out their difficulties with the Metropolitan Railway Company before a Parliamentary Committee, and an arbitration under the direction of the Board of Trade was adopted by the common consent of both companies. They were much indebted to the Board of Trade for the promptitude with which they made their award when they got the report from the tribunal to which this question was submitted. If the two companies blundered, it was not from the want of a very explicit warning from the Board of Trade, because so far back as May 28th, the Board of Trade hoisted a danger signal and warned them against the adoption of any particular system. This company had made two distinct propositions in the direction of unity to the Metropolitan Company. They recognised that the Inner Circle system was one which could only be efficiently worked in the interests of the London traveller by the unison of the two partners. One of the two propositions was this—that in place of the duplication of electrical plant for the generation and supply of electrical current, each company should take its supply from the great generating power house which was about to be erected at Lot's Road, Chelsea. The Metropolitan Company invited a few days ago tenders for the construction of a large power house at Neasden. He had informed Colonel Mellor, the chairman of the Metropolitan, at a meeting a day or two ago, that this company would be prepared to supply from their own generating station at a lower rate than the Metropolitan Company could possibly generate their current for the operation of their railway electrically. It seemed to him to be a waste of money for the Metropolitan Company to spend £300,000, or more, in the erection at Neasden of a duplicate power house. He would like to remind them, and the Metropolitan proprietors, of the offer which was made by the Traction Company to the Metropolitan, and which he thought was rather summarily dismissed about six months or a year ago, namely, the proposals made by the Traction Company that they should undertake the leasing and the working of the Metropolitan Railway, giving the proprietors of that undertaking 3½ per cent. guaranteed on their ordinary stock, and all prior charges properly protected. Notices to treat had been given for the whole of the lands required for the power house at Chelsea. They had already settled with some of the landholders and some of the lessees. The borings would be sunk the next week, and the contracts had been largely let by the traction company for the machinery required for that power house. The power house would be of such a character as to generate a supply up to about 60,000 KW. It would be the largest power house ever erected in this country, and it was intended to

supply not merely the District Railway, but several other railways which might be worked in close association with it. The time required for building the power house was the test of the time when they could instal electrical traction upon the line. The balance of the business was comparatively easy, so far as time was concerned. They thought it would take from 18 months to probably two years to build the power house, and, therefore, they had to look forward to that period of patient waiting and economical administration before they would be able to see the full reward of the enterprise into which they had entered. They were not going to have any overhead trolley wires, carrying a current which they thought would be dangerous—a voltage of 11,000 volts. It would be better, they were of the opinion, to adopt a system of sub-stations, through which their current was carried from the power house, and where it was reduced by transformers and rotary converters into a safe and ordinary current of about 550 volts. Knowing that the great railway systems of America were being operated, not merely in Chicago, but in the City of New York and various other towns like Pittsburg and Baltimore, upon the direct-current system, and when they found that they were working safely, economically, and regularly, they did not think it wise to plunge into an experiment which had only been tried upon one or two little mountain railways in Switzerland. Possibly Colonel Mellor was right when he said it was evident from the report that the Ganz system possessed features of such novelty and importance, that it amounted to a new departure in electric traction. But the time might come when they might have aerial forms of locomotion; but, as practical people, he thought they ought not to try experiments. He admitted that the Ganz system had the backing of Sir. W. Preece, but that gentleman did not come to the tribunal to explain his reasons in the witness-box, and he somewhat modified his opinion in the Parliamentary Committee room. They would run the railway upon the principle of what was called the multiple unit. The trains would probably be 60 in number, and would consist of seven coaches, three of which would be motor cars, and four what were called trail cars. The carriages would be 50 ft. in length. The total length of the trains would be 350 ft., and would seat 338 passengers. They would be so constructed that in the slack hours of the day they would be divisible into two sections, and run in short lengths. They were constructed with a motor car at each end and one car in the middle, so that they could go forward and backward without reversing the engine. The service would be accelerated. The average rate of running now was about 10 miles per hour. They would undertake to run at least 15 miles per hour, and the trains would have a carrying capacity of at least 70,000,000 passengers per annum, and with the same capacity in rolling stock, they would be able to carry about 30 per cent. more. In the city of Chicago, which had about a quarter of the population of London, the elevated railway system carried 256,000 passengers a day of 44 miles; the Manhattan Railway, of New York, carried 180,000,000 of passengers per annum on its 36 miles. The proposed electrical equipment of the District would provide for 60 trains, and, if necessary, 100 trains, and the carrying capacity, as he had said, would be at least 70 millions of passengers a year for the 60 trains. They were working in friendly relationship with the London & North-Western, who had running powers over their line from Earl's Court to Mansion House, and they had come to an agreement with that company to haul forward their trains by electric motor if the North-Western Company did not elect to run their own trains by that method. They hoped also, by means of their arrangements with the Great Western and the Great Central, with whom they were now entering into an agreement for a junction at Harrow with their railway, to develop a very considerable amount of goods traffic through to the East-end of London over this line and over the Tilbury. That goods traffic could be hauled forward without any difficulty by means of the electric engines to which he had alluded.

Costa Rica Electric Light and Traction Company.

THE meeting of this company was held at Winchester House, E.C., on 23rd ult, Mr. W. F. Leese presiding.

The CHAIRMAN said that there had been a very considerable and progressive business done. Two years ago they made £3,800; last year, £6,800; and this year they had made practically £9,000. The directors considered from the first that the working capital of £10,000 would very shortly be encroached upon, because, although there was an equipment of the tramway, as provided for in the contract, still there were no spare parts or duplicates of machinery in case of a break-down. For these things, and for general and necessary equipment, they soon had to encroach very largely on the working capital. Then in order to comply with the very urgent demand for more light and tramway accommodation, they had to at once start extensions. They represented to Mr. Keith that they had no working capital with which to do it, and thereupon he said that he would do the work and would postpone the payment for interest, &c. He had done that in a very generous and complete manner, and the amount was £15,446. There had been an increase in the business all round. Last year they increased from 4,951 to 6,896 of 16-C.P. lamps. The number of passengers carried during the year was 687,616, or an increase of 37 per cent. over the previous year. Since the close of the financial year 2½ miles of additional tramway have been opened to traffic. The earnings of that extension were very considerable, being about £30 a week, and it would be a very valuable asset in future business. The profit of £9,000 roughly represents over 40 per cent. of the total business done. The trade itself was lucrative, and when they took into consideration that the business had been done under the great disadvantage of not having a concentrated power, but a series of small water-powers—four in number, several miles apart—and therefore necessitating a largely increased staff, there was ample margin left under more favourable conditions for still better profits in the future. As a matter of fact, they had only touched the mere fringe of the business. There are in the central valley of Costa Rica some 200,000 inhabitants. These are all actively demanding the light and power, and not only have they, through their representatives, sent memorials begging the company to extend the tramway and lighting facilities to them, but they had even gone behind the company's back to the Government and the Municipality of San José, and asked them to exercise pressure to induce them to favour them and the suburbs all round. The special circumstances of Costa Rica were very favourable to this particular business. There was no coal; the chief centre of population was over 100 miles from the coast, and 5,000 ft. above sea level, and therefore railway traction is extremely expensive. It was a country where there were no roads of any consequence only rough tracks, and where the only thing which did not break down was the ox-wagon or cart, by means of which only are goods brought to the rail and all supplies brought to the capital. The question, therefore, of providing cheap locomotion and light was one which affected the interests of all the inhabitants. The company started three years ago to supply these facilities, and it had done so to the best of its ability to the limit of its capital on the one side and its water concessions on the other. These water concessions represent about 1,000 H.P. Three or four years ago it was estimated that that would be the minimum obtainable in the dryest portion of the dry season, but recently there has been a succession of droughts, which has affected the volume of water power. The consequence was that during the last two years, and more especially during the past dry season, they had not had sufficient water power for actual requirements. In other words, the tramcars had been standing still during some hours in the evenings for weeks at a time, because they were not able to supply the current to them, and at the same time to comply with the lighting obligations. The question of further water power had become acute, and it was absolutely necessary for them to consider without delay the advisability of a considerable expansion in that direction. The report and accounts to June 30th, 1901, were adopted.

British Electric Plant Company.

THE first annual meeting of this company was held at Glasgow on December 30th. Mr. J. G. Stewart presided, and, in the course of his remarks, said that the work since September had been erecting the factory at Alloa, and equipping it with machines to manufacture the special electrical plant, which work was now approaching completion. They had installed about one-half the machinery, which was all they had received, and they were quoting for electrical plant to be made at the works during the coming year. The electric supply plant was in running order, but the Town Council of Alloa were not in a position to fix a date when they would be able to take a regular supply of current for distribution. There was naturally no profit and loss account, and consequently no balance-sheet, but the statement showed on the one side the moneys they received, and on the other what they had done with these, leaving a sum in cash in bank and on hand of £8,715.

Stock Exchange Notices.—The Committee has ordered the undermentioned securities to be quoted in the Official List:—General Electric Company (1900), Limited—7,000 vendors' 5 per cent. cumulative preference shares of £10 each, fully paid, Nos. 1 to 7,000; and £50,000 vendors' 4 per cent. first mortgage debenture stock.

Crompton & Co., Limited.—The directors have declared an interim dividend, for the half year ended September 30th last, at the rate of 6 per cent. per annum, free of income-tax, being the same rate as the interim dividend last year, and payable on and after January 15th next.

Randall's Telephone Patents.—Our representative was refused admission to the meeting of this company, held at 65, New Broad Street, E.C., on Monday, and he was not allowed to have a copy of the directors' report which came before the meeting.

South Lancashire Electric Traction and Power Company.—Warrants for the interest to December 31st, 1901, on the 4½ per cent. first mortgage debenture stock, payable January 1st, 1902, were posted on December 31st.

Electric and General Investment Company.—Warrants for the interim dividends on the 6 per cent. cum. pref. shares, and of 10 per cent. on the ordinary shares have been posted.

Charing Cross and Strand Electricity Supply Corporation.—Warrants for the interest on the 4 per cent. debenture stock have been posted.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending Dec. 27th were £532; corresponding week last year, £547; decrease, £15. Total to date, £26,064; corresponding period last year, £23,279; increase, £2,785. Miles of track open, 8¼.

Blackpool and Fleetwood Tramways.—The receipts for the week ending December 23rd were £140; corresponding week last year, £165; decrease, £25. Total receipts to date, £20,789; corresponding period last year, £20,164; increase, £625. The receipts for the week ending December 28th were £160; corresponding week last year, £221; decrease, £61. Total receipts to date, £20,949; corresponding week last year, £20,385; increase, £564.

Bristol Tramways and Carriage Company.—The receipts for the week ending December 27th were £4,580; corresponding period last year, £4,970; decrease, £390.

British Electric Traction Company.—The following returns are issued of the undertakings of this company for the week ending December 20th:—

Company.	Amount £	Comparison with corresponding week of last year. + £	Comparison with corresponding week of last year. — £	No. of weeks.	Aggregate. Amount. £	Aggregate. Inc. or Dec. + £	Aggregate. Inc. or Dec. — £
Croydon*	509	227	—	51	17,385	2,448	—
Devonport	385	—	—	26	10,235	—	—
Dudley—Stourbridge	569	4	—	51	31,309	16,014	—
Gateshead	517	—	—	32½	19,110	—	—
Greenock-Pt. Glasgow	317	—	—	11	3,149	—	—
Hartlepool	157	—	29	51	11,355	1,237	—
Kidderminster ..	93	5	—	51	6,117	695	—
Merthyr	170	—	—	37	9,084	—	—
Oldham—Ashton ..	426	—	8	51	25,208	3,126	—
Poole	172	—	—	37	10,226	—	—
Potteries	1,337	108	—	51	71,236	19,799	—
Southport†	112	3	—	51	8,158	—	2,801
South Staffordshire‡	674	—	39	51	39,252	2,406	—
Swansea	405	3	—	51	22,294	4,297	—
Taunton	47	—	—	17½	1,362	—	—
Tynemouth	110	—	—	39	10,560	—	—
Wolverhampton Dist.	68	16	—	51	3,361	788	—

* Partly horse. † Reconstructing. ‡ Partly steam.

City and South London Railway.—The receipts for the week ending Dec. 29th were £3,103; corresponding week last year, £1,704; increase, £1,399. Total from July 1st to date, £58,674; corresponding period last year, £43,273; increase, £15,401. Miles open, 6½; corresponding period last year, 4½.

Central London Railway.—The receipts for the week ending Dec. 21st were £7,289; corresponding week last year, £6,135; increase, £1,154. Total receipts from July 1st (25 weeks), £155,403. Miles open, 6. Week ending December 28th, £5,928; corresponding week last year, £4,911; increase, £1,017. Total from July 1st (26 weeks), £161,327.

Dover Corporation Tramways.—The receipts for the week ending December 21st were £165 6s. 4d.; corresponding week last year, £182 8s. 11d.; decrease, £17 2s. 7d. Total to date, £10,960 15s. 10d.; corresponding period last year, £10,433 8s. 0½d.; increase, £527 7s. 9½d. Miles of track open, 3. Car miles run, 1901, 5,341. Number of cars, 1901, 12; 1900, 11. The receipts for the week ending December 28th were £170 13s. 1d.; corresponding week last year, £185 11s. 10d.; decrease, £14 18s. 9d. Total to date, £11,131 8s. 11d.; corresponding period last year, £10,618 19s. 10½d.; increase, £512 9s. 0½d. Car miles run, 1901, 5,364; 1900, 4,169.

Dublin United Tramways Company.—The receipts for the week ending December 20th were as follows:—D.U.T. Co., electric cars, £3,398 3s. 0d.; D.S.D. Co., electric cars, £682 7s. 1d.; total, £4,080 10s. 1d.; corresponding period last year—D.U.T. Co., electric cars, £3,546 4s. 2d.; ditto, horse cars, £22 15s. 0d.; D.S.D. Co., electric cars, £762 15s. 5d.; total, £1,331 14s. 7d.; decrease, £251 4s. 6d.; aggregate to date, £115,693 0s. 10d.; aggregate to date last year, £114,885 19s. 2d.; increase, £807 1s. 8d. The mileage worked is 45 miles electrically, as against 43 miles electrically, and two miles by horses, for the corresponding period last year. Week ending December 27th:—D.U.T. Co., electric cars, £3,746 17s. 9d.; D.S.D. Co., electric cars, £746 10s. 8d.; total, £4,493 8s. 5d.; corresponding period last year—D.U.T. Co., electric cars, £3,738 16s. 1d.; ditto, horse cars, £23 3s. 7d.; D.S.D. Co., electric cars, £816 14s. 4d.; total, £4,578 14s. 0d.; decrease, £85 5s. 7d.; aggregate to date, £120,186 9s. 3d.; aggregate to date last year, £119,620 0s. 4d.; increase, £566 8s. 11d.

Glasgow Corporation Tramways.—Week ending December 21st, £10,209, compared with £9,247 for same period last year. From the commencement of present financial year (June 1st), £358,700, compared with £273,552 for same period last year. The receipts for the week ending December 28th were £10,154 2s. 9d., compared with £9,530 9s. 8d. for same period last year.

Liverpool Overhead Railway.—The receipts for the week ending Dec. 22nd were £1,425; corresponding week last year, £1,516; decrease, £91. Total from July 1st to date, £39,164; corresponding period last year, £41,174; decrease £2,010. Miles open, 6 miles 57 chains. Week ending December 29th, £1,340; corresponding week last year £1,397; decrease, £157. Total from July 1st, £40,404; corresponding period last year, £42,571; decrease, £2,167.

STOCKS AND SHARES.

New Year's Day, 1902.

THE Stock Exchange has entered upon the second year of the Twentieth Century in much more hopeful vein than it embarked upon the first. The approaching end of the South African campaign is largely—perhaps, mainly—responsible for the happier feeling noticeable in all the markets. Last year was not one to be regarded with charity by most investors. Consols, for instance, fell from 97⅞ to 93⅞; London and North-Western stock from 179½ to 168; and Brighton Railway "B" from 174½ to 157. Investment stocks in all departments are generally lower, but the little electrical railway section is a startling exception. Waterloo and City Ordinary has drooped, but the conditions attaching to the stock are so purely connected with the money market, inasmuch as the dividend is virtually fixed at 3 per cent., that it is no criterion to electrical railway enterprise as a whole. The past year has been one of immense strides in the latter industry, and part of the depreciation in values of steam railway securities is due to fears of competition by the coming system. We annex a "little list" showing the principal changes of the twelvemonth:—

Stock or share.	Dec. 31, 1900.	Dec. 31, 1901.	Rise or fall.
Central London	9½ = 95	10⅞	+11½
City and South London ..	54	63	+ 9
Do. shares	5	6¼	+ 1¼
Waterloo and City	95½	92⅝	− 3
Metropolitan Consolidated ..	83	77	− 6
Metropolitan District	29½	29	− ½

The comparatively slight fall in District stock, as compared with Metropolitan Consolidated, is due to the buying of the former by those who were anxious to secure control of the line, while Metropolitan stock has had no such support.

In the Electricity Supply section an irregular tendency is disclosed as regards quotations. Some of the outstanding features of the year are the rapid growth of capital expenditure necessitated by expansion of business, the price of coal and fuel, and the quiet absorption of Debenture stocks during the past six months. Coming to actual variations in values, and contenting ourselves with the quotations of the best-class Ordinary shares, we find the following comparisons:—

Share.	Dec. 31, 1900.	Dec. 31, 1901.	Rise or fall.
Brompton and Kensington ..	7⅞	9	+1⅛
Charing Cross	10	8½	−1½
Chelsea	6⅜	5⅜	−1
City of London	9½	9½	No change.
County of London	9	9	No change.
Metropolitan	12½	14½	+2
Notting Hill	15	15⅝	+ ⅝
St. James's	15½	16	+ ½
Westminster	13	12	−1

The City of London Company, distressful though its days of 1901 have proved, comes out remarkably well in the showing when it is remembered that the proprietors have received no dividend on the Ordinary shares since the 8s. paid in March, 1900. Metropolitans have strengthened their position appreciably, and the new generating station at Willesden, added to the agreement between the company and the Marylebone authorities, deserve gratitude from the shareholders for the part they have played in assisting the rise. The large growth of capital expenditure, already referred to, should bear fruit in the New Year, and with a reduction in coal bills we look forward to seeing to-day's prices substantially improved upon when the reviewer comes to next January's task.

Quite at the end of the old year the telegraph market was rudely shaken by the presumed flashing of a single letter from England to Newfoundland through the instrumentality of Signor Marconi's wireless system of telegraphy. Prices, after keeping firm throughout the twelvemonth, except for an earlier Marconi spasm in the spring gave way on all hands, and the Telegraph list exhibits an almost unbroken series of declines. That the selling has been considerably exaggerated is admitted by many a good authority within the Stock Exchange and without, and the present slump affords a good opportunity for securing at cheap rates such securities as Eastern Ordinary, Eastern Extension shares, and, as a more speculative investment, Anglo-American Preferred stock. To come to our prices:—

Stock or share.	Dec. 31, 1900.	Dec. 31, 1901.	Fall.
Anglo-American "A"	10¼	8⅛	2
" "B"	98	92⅛	5⅛
Commercial Cable	175	172½	2½
Eastern	138½	135	3½
Eastern Extension	14¼	13⅛	1⅛
Great Northern	32	31	1
Reuter's	7⅛	7⅛	No change.
West India and Panama ..	¾	⅝	⅛
Western Telegraph	14	12⅞	1⅛
National Telephone	4⅜	3⅝	¾
Oriental Telephone	1	1	No change.

National Telephone shares bid up to 4½ on the eve of the publication of the Government agreement, have tumbled to 3⅝ on the storm of hostility evoked by the arrangement. Nor is the latter as favourable as some had hoped for, although it unquestionably leaves the company in a stronger position for the next few years than it had previously occupied.

British Electric Tractions began and ended the year at 14, but British Westinghouse Preference gained 15s., advancing from 4¾ to 5½, thereby fulfilling the expectations formed of their prospects when they stood at the lower figure. Callenders at 17 are a round £4 to the good, as a result of the year, while Henleys at the same price show a rise of 3½ points. Edison & Swan shares, which stood at 2 this time last year, are now nominally quoted at 5s. after being practically unsaleable at the time when the Committee issued its appalling report. Telegraph Construction are a shade easier, Telegraph Manufacturing a fraction higher, than they were at the end of last century. It has been a year of numerous new issues, and the rapid development of electrical tube-cum-tramway schemes, particularly in West London, has brought down London General Omnibus stock from 150 to 100. All appearances go to show that 1902 will exalt companies connected with the more modern illuminant and power in a higher degree than its predecessor has done.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotations Dec. 18th.	Closing Quotation Jan. 1st.	Business done during week ended Jan. 1st, 1902. Highest.	Lowest
82,300	African Direct Telegraph, 4 % Debs	100	...	...	...	99 —102	99 —102	...	...
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	...	...	...	3½— 4½	3½— 4½	...	...
119,700£	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	78 — 83	78 — 83	...	...
804,720	Anglo-American Telegraph	Stock	£3 9s.	73/6	3½%	50 — 53	49 — 52	50	47½
3,097,640	Do. do. 6 % Pref	Stock	6 %	6 %	6 %	94 — 96	91 — 94	95½	86½
3,097,640	Do. do. Deferred	Stock	18s. %	£1 7s.	5s.%	8 — 8½	8 — 8½	8 7/16	7 13/16
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	5 %	3½— 4	3½— 4	...	...
13,333,300$	Commercial Cable	$100	8 %	8 %	...	180 —190	170 —175	...	
1,741,029£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	101 —103	96 — 98 xd	101¼	97
16,000	Cuba Telegraph	10	8 %	7 %	...	5 — 6	5 — 6	...	...
6,000	Do. 10 % Pref.	10	10 %	...	...	13½ — 14½	13½ — 14½	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	3 — 4	3 — 4	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	8½ — 9½	8½ — 9½	...	...
30,000£	Do. do. 4½ % Debs.	50	...	...	...	100 —104 %	100 —104 %	...	
60,710£	Direct United States Cable	20	3½%	3½%	3½%	10½ — 10⅝	9½ — 10½	10½	9⅛
104,300£	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	100 —103	99 —102	...	
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	138 —142	130 —140	139	131½
1,930,807	Do. 3½ % Pref. Stock	100	...	...	...	91 — 94	91 — 94	91½	91
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	112 —115	111 —116	...	...
300,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	13⅝ — 14¼	13 — 14	14	12½
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	113 —118	113 —118	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	5¼%	...	100 —103	100 —103	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	100 —103	100 —103 %	...	...
180,227	Globe Telegraph and Trust	10	5½%	5½%	5½%	10⅜ — 11¼	9 — 10	10½	9¼
180,042	Do. do. 6 % Pref.	10	6 %	...	...	14½ — 15	14 — 15	14½	14
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	15 %	30 — 32	30 — 32	...	...
78,000£	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	99 —103 xd	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	40 — 44	40 — 44	40	...
100,000£	London Platino-Brasilian Telegraph, 6 % Debs.	100	...	...	...	103 —106	103 —106	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	2½%	...	¼— ½	¼ - ½	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	¾— 1	¾ - 1	...	
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	5 %	3½— 3¾	3½— 3⅝	3 11/16	3⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅝— 4⅞	4⅝— 4⅞	4⅝	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	95 — 98	93 — 96 xd	93	...
500,000£	Do. 4 % Deb. Stock Red.	100	...	...	4 %	100 —103	99 —103 xd	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	6 %	5/16— 1 1/16	1⅛—1 1/16	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	...	...	...	100 —103	99 —102 xd	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8	...	...
3,303	Submarine Cables Trust	Cert.	...	...	...	123 —128	120 —125	...	...
58,000	United River Plate Telephone	5	6 %	7 %	...	5 — 5½	5 — 5½xd	...	...
40,000	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4¾— 5¼	4½ — 5 xd	...	...
179,947£	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	102 —105 xd	...	...
155,600	West African Telegraph, 5 % Debs....	100	...	...	...	100 —103	100 —103	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	⅛ - ⅜	⅛ - ⅜	...	...
150,000£	Do. do. 4 % Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	101 —104	101 —104	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	7 %	13½ — 14 xd	12 — 13	13 5/16	13½
75,000£	Do do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	104 —107	102 —105 xd	...	
348,777£	Do. do. 4 % Deb. Stock Red.	100	...	...	...	103 —106	101 —104 xd	...	...
88,321	West India and Panama Telegraph	10	2 %	8%	...	⅜— ⅝	⅜ - ⅝	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	...	...	...	5 — 6	5 — 6xd	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	...	...	...	3½ - 4½	2½ - 3½	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	102 — 105	100 —103 xd	...	...

ELECTRICITY SUPPLY COMPANIES.

100,000	Blackheath and Greenwich Dist. Electric Light, Ord. ...	1	...	...	...	⅜— ⅝	⅜— ⅝	...	...
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs.	100	...	...	...	97 — 102	97 —102	...	...
19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	6 %	8½— 9	8⅜— 9½	...	...
20,000	Do. do. 7 % Cum. Pref....	5	...	...	...	8¼— 8⅜	8½— 9	8⅞	...
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	9 %	8 — 9	8 — 9	...	...
50,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5 — 5½	5 — 5½	...	...
250,000	Do. do. do. 4% Deb. Stock Red.	100	...	...	...	103 —105 xd	103 —105	104¼	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	5½%	5⅜— 6¼	5½— 6	...	...
150,000£	Do. do. do. % Deb. Stock Red. ...	Stock	...	...	...	109 —112	108 —111 xd	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579...	10	6 %	4 %	0 %	9 — 10	9 — 10	9¼	9 3/16
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	12 — 13	12 — 13	12⅝	...
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	122 —127	121 —126 xd	...	...
200,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	...	...	...	102 —105	101 —104 xd	105	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	4 %	4 %	8½— 9½	8¼— 9½	9⅛	8⅞
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	12 — 13	12 — 13	...	...
400,000£	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	105 —108	104 —107 xd	...	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	6 %	6 %	7 %	5½— 6	5½— 6	5 13/16	...
20,000	Do. do. 6 % Cum. Pref.	...	...	...	...	5½— 6	5½— 6	...	...
120,000£	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	105 —108	105 —108	107½	...
21,000	Kensington and Knightsbridge Electric, Ord.	5	...	...	...	11 — 12	11 — 12	...	...
90,000	Do. do. do. 4 % Deb. Stock	Stock	...	...	...	101 —104	103 —106	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1½— 1⅝	1½— 1⅝	...	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	3½— 4½	3½— 4½	4½	4
250,000£	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	94 — 98 xd	94 — 98	...	
98,769	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	6 %	14 — 14½	14 — 15	14⅝	14¼
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	113 —116	111 —115 xd	...	...
250,000£	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	97 —100	96 — 99 xd	99⅜	99½
8,652	Notting Hill Electric Lighting	10	6 %	7 %	7 %	15 — 16	15 — 16	15	15⅜
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15½— 16½	15½— 16½	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 9	8½— 9½	9⅛	...
150,000£	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	98 —101	97 —100 xd	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000£	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
109,518	Westminster Electric Supply, Ord.	5	12 %	13 %	10½%	11½— 12½	11½— 12½	...	...

* Subject to Founders Shares.
‡ Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
§ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Dec. 18th.	Closing Quotation Jan. 1st.	Business done week ended Jan. 1st, 1902. Highest	Lowest.
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	4⅛ — 5⅛	4⅛ — 5⅛	...	...
300,000*l*	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	87 — 91	87 — 91	...	...
62,074	British Electric Traction	10	6 %	8 %	9 %	13⅛ — 14⅛xd	13⅛ — 14⅛	13⅞	13⅜
90,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12 — 12½	12 — 12½	12½	12 1/16
600,000*l*	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	122 —125	124 —127	125½	123¼
70,000	British Insulated Wire Ord.	5	15 %	20 %	15 %	8 — 9	8 — 9	8⅝	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5½ — 5⅝	5⅛ — 6	...	...
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	...	...	8 %	⅞ — 1	⅞ — 1	...	...
50,000	¶ „ „ „ 6 % Cum. Pref.	£1	...	...	6 %	1 1/16 — 1 1/16	1 1/16 — 1 1/16 xd	1⅛	...
105,731	Brush Elecl. Enging., Ord., 1 to 105,731	2	4 %	5⅛ %	5 %	1⅛ — 1⅛	1⅛ — 1⅛	...	...
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	1⅞ — 2⅛	1⅞ — 2⅛	2	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	102 —105	102 —105	103¼	...
125,000*l*	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	99 —102	99 —102	99	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	15 %	15½ — 16½	16½ — 17½	17½	17⅜
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5⅜ — 6¼	5⅜ — 6¼xd	6 1/16	...
90,000*l*	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	112 —116	110 —114 xd	...	...
1,969,800	Central London Railway, Ord. Stock	Stock	...	...	...	106 —109	105 —108	108½	106½
440,100	Do. do. 4 % Pref. Stock	Stock	...	...	...	105 —108	105 —108	107¾	...
440,100	Do. do. Def. do.	Stock	...	...	...	107 —110	106 —109	108½	...
855,000	City and South London Railway	Stock	2⅛%	1⅞%	1¼%	64 — 66	62 — 64	64	62½
47,500	Do. do. Ord. shares Nos. 22,501 to 70,000	10	...	...	...	6 — 6½	6 — 6½	6 5/16	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7½%	8 %	3 — 3½	3 — 3½	3⅜	...
100,000*l*	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	100 —105	100 —105	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	2½%	⅛ — ⅜	⅛ — ⅜	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	2½%	1½ — 2½	2 — 3	...	...
344,023*l*	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	80 — 85	78 — 83 xd	...	...
100,000*l*	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	84 — 89	84 — 89	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1⅜ — 2¼	1⅜ — 2¼	1⅞	...
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390... ...	2	7 %	...	...	2½ — 3	2½ — 3	...	...
182,500*l*	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	98 —102	98 —102	100½	...
18,000	General Elec. Co. (1900) 5 % Cum. Pref.	10	...	...	...	10 — 10½	9¾ —10¼ xd	...	...
150,000	Do. do. 4 % Mort. Deb.	Stock	...	...	...	99 — 102	99 —102	100½	100¼
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	20 %	16½ — 17½	16½ — 17½	17¼	16 13/16
35,000	Do. do. do. 4½ % Pref.	5	...	4½%	4½%	5½ — 6	5½ — 6	...	...
50,000*l*	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	112 —116	112 —116	112	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	23 — 24	21½ — 22¼xd	23	22⅝
300,000*l*	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	100 —103	100 —103	101	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3⅜%	3¼%	5⅛ — 5⅜	5⅞ — 6⅛	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5	...	11⅞ — 12⅛	12 — 12½	...	...
7,500	Parker (Thomas), Limited, Ord., Nos. 1 to 7,500	10	...	...	...	15½ —16½	15½ — 16½	...	...
	§Rosling, Appleby & Fynn 6 % Cum. Pref.	£1	...	...	6 %	19/- to 20/-	... — ...		...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	17½%	38 — 42	37 — 41	38¾	...
150,000*l*	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	104 —106	104 —106	...	...
25,000	Telegraph Manufacturing, Ord. Nos. 1 to 25,000	5	8 %	12 %	12 %	10½ — 11½	10½ — 11½	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000 ...	5	...	...	...	5½ — 6	5½ — 6	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	91 — 94	91 — 94	93½	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § From Bradford Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance 2/—4/-
National Electric Free Wiring, 17/6 paid, ⅛—¼.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 15½—16.
Do. do. Pref. (£10 pd.), 10⅛—10¾.

* From Birmingham Share List. ¶ From Manchester Share List.

Bank rate of discount 4 per cent. (October 31st, 1901).

MARKET QUOTATIONS, Wednesday, January 1st.

CHEMICALS, &c.		This week.	Week before last.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a „ Nitric	per cwt.	22/-	22/-	..
a „ Oxalic	per cwt.	32/-	32/-	..
a „ Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	80/-	80/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a „ „ „	per ton	£80	£80	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£13	£13	..
a Bensole (90 %)	per gal.	7/-	7/-	..
a „ (50/90%)..	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£19	£22	£3 dec.
a Lead, Nitrate	per ton	£24	£24	..
a „ White Sugar	per ton	£31	£31	..
a „ Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160°C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	3d.	3d.	..
a „ Caustic (76/80%) ..	per ton	£24	£24	..
a „ Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	125/-	120/-	5s. inc.
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 5	£6 5	..
a „ Recovered	per ton	£5 10	£5 10	..
a „ Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a „ Crystals	per ton	£8	£8	..
a Bichromate, casks ..	per lb.	2¼d.	2¼d.	..

METALS, &c.				
b Aluminium Ingots, in ton lots	per ton	£148	£148	..
b „ Wire, in ton lots	per ton	£224	£224	..
b „ Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£75 to £125	£75 to £125	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	¼d. dec.
c Tube (brazed)	per lb.	8¾d.	9d.	¼d. dec.
c „ „ (solid drawn) ..	per lb.	7¾d.	8d.	¼d. dec.
c „ Wire, basis	per lb.	7¼d.	7¾d.	¼d. dec.
c Copper Tubes (brazed) ..	per lb.	9½d.	9¾d.	¼d. dec.
c „ „ (solid drawn) ..	per lb.	9¼d.	10¼d.	¼d. dec.
g Copper Bars (best selected) ..	per ton	..	£71	..

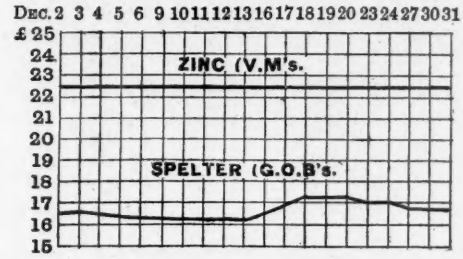
METALS, &c. *(continued.)*		This week.	Week before last.	Inc. or Dec.
g Copper Sheet	per ton	..	£71	..
g „ Rod	per ton	..	£71	..
c „ (Electrolytic) Bars ..	per ton	£70	£80	£10 dec.
c „ „ Sheets ..	per ton	..	£88	..
c „ „ Rod ..	per ton	£75	£82	£7 dec.
c „ „ H.C. Wire ..	per lb.	8¼d.	9¼d.	1d. dec.
f Ebonite Rod	per lb.	3/-	3/-	..
f „ Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/5	1/5	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/6 to 3/7	3/5 to 3/7	dec.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i „ Pig (Cleveland warrants) ..	per ton	43/3½	43/4	¼d. dec.
i „ Forgings, according to size	per ton	From £11	From £11	..
i „ Scrap, heavy	per ton	47/6 to 50/-	47/6 to 50/-	..
i „ Wire, galvanised No. 8 ..	per ton	£10	£10	..
g Lead, English Ingot	per ton	..	£10 10 to £10 12 6	..
g „ „ Sheet	per ton	..	£13 10	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	..	£8 17 6	..
d Mica (in original cases), small ..	per lb.	8d. to 9d.	8d. to 9d.	..
d „ „ „ medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d „ „ „ large ..	per lb.	3/8 to 7/8	3/8 to 7/8	..
p Phosphor Bronze, plain castings	per lb.	11½d. to 1/2	1/0½ to 1/8	1d. dec.
p „ rolled bars & rods	per lb.	1/- to 1/3	1/1 to 1/4	1d. dec.
p „ „ strip & sheet	per lb.	From 1/2	From 1/8	1d. dec.
o Platinum	per oz.	£4 1	£4 1	..
p Silicium Bronze Wire	per lb.	10d. to 1/-	10¾d. to 1/0½	dec.
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i „ „ in bars		£58	£58	..
g Tin, block	per ton	..	£112 to £113	..
g „ foil	per lb.	1/6	1/6	..
n „ wire, Nos. 1 to 16	per lb.	1/7	1/7	..
p White Anti-friction Metals — "White Ant" brand	per ton	£35 to £65	£35 to £65	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7d.	7d.	..
j „ 6 ths. Flax	per lb.	5½d.	5½d.	..
j „ 3 ply 10 lbs. Russian ..	per lb.	4½d.	4½d.	..
j „ 10 lbs. Russian, single ..	per lb.	4¼d.	4¼d.	..
j „ 180 lbs. Jute rove	per ton	£10 2 6	£10 2 6	..
k Zinc, Sh's. (Vieille Montagne mod.)	per ton	£21 10	£22 10	£1 dec.

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

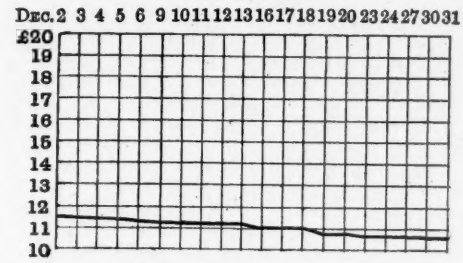
Quotations supplied by { *f* India-Rubber, G.-P. and Telegraph Works Co., Ltd. *g* Messrs. James & Shakespeare. *h* Messrs. Edward Till & Co. *i* Messrs. Bolling & Lowe. *j* Messrs. Walter H. Hindley & Co.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd *p* The Phosphor Bronze Company, Ltd.

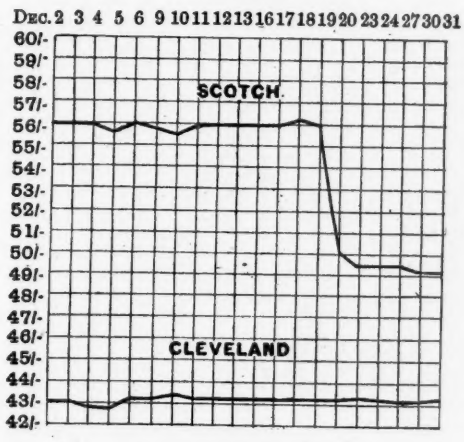
METAL MARKET.—Fluctuations in December.



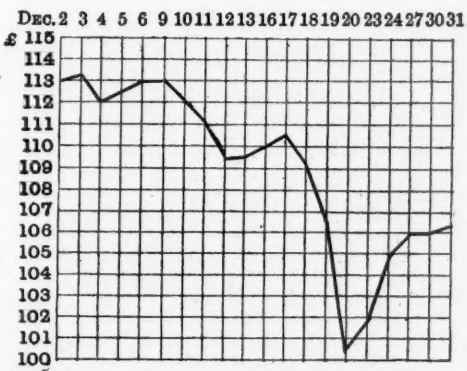
LEAD (ENGLISH).



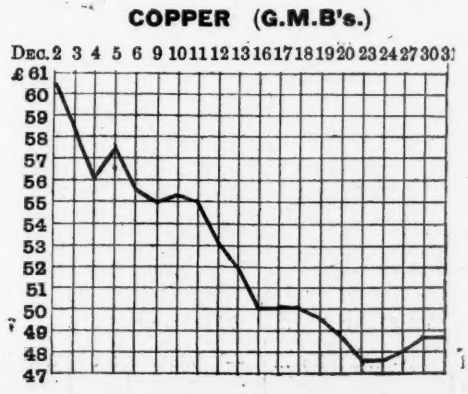
IRON.



TIN.



COPPER (G.M.B's.)



CURRENT SPECIFICATIONS.

LXXXVI.—BARKING EXTENSION PLANT.

Summary.

Extent of Contract.—Supply and erection upon prepared foundations of new boiler, feed pump, steam dynamo, motor balancer and accessories.

Size of Boiler.—To be of water-tube type, capable of evaporating 12,000 lbs. of water per hour with feed water supplied at 150° F.

Working Pressure.—175 lbs. per sq. in.

Superheater.—To be capable of adding 50° F. of superheat to 12,000 lbs. of steam at normal temperature for 175 lbs. square inch pressure per hour.

Mechanical Stoker.—Of approved type to be provided.

Boiler Feed Pump.—Electrically-driven three-throw pump to be provided, capable of pumping 1,500 gallons per hour against 170 lbs. square inch pressure. Motor will be supplied under separate contract.

Water Meters.—Two to be supplied, each capable of passing 1,500 gallons of hot water per hour at a pressure of 170 lbs. sq. in.

One of similar size to be provided, arranged for hot water at ordinary pressure.

Storage Tank.—One to be provided and fixed in prepared position, 25 ft. long × 18 ft. wide × 6 ft. deep.

Steam Dynamo.—One to be provided and fixed on prepared foundations. To develop 250 KW. at normal load working, condensing with 26 in. vacuum and 150 lbs. square inch pressure.

Specified Overload.—Ten per cent. for two hours without injury.

Speed.—Optional with tenderer. Standard types of plant may be quoted.

Type of Engine.—To be of vertical compound type fitted with piston valves.

Range of Governing.—When whole load thrown off, momentary variation not to exceed 5 per cent., or permanent variation 3 per cent. To be capable of hand regulation to extent of 5 per cent.

Type of Dynamo.—To be multipolar, compound wound, normal output either 520 amperes at 480 volts or 450 amperes at 550 volts. To compound from 500 volts at no load to 550 volts at terminals at full load.

Permissible Temperature Rise.—Not to exceed 70° F. after six hours' full load run, or at end of a two hours' run at 10 per cent. overload immediately following above full load run.

Specified Steam Consumption.—Not to exceed 26 lbs. per KW.-hour at full load working condensing with 150 lbs. per square inch steam, or 29 lbs. per KW.-hour at full load working non-condensing.

Motor Balancer.—To consist of three machines rigidly coupled together. Each of two dynamos to develop 40 KW., remaining machine to act as motor, and to be capable of driving both dynamos at full load when supplied with current from traction dynamo.

Voltage of Generators.—245 volts under normal conditions at terminals.

Switchboard Extension.—To be in accordance with specified requirements to suit the additional plant to be installed.

Induced Draught Plant and Steel Chimney.—To be supplied as specified.

Specified Date of Delivery.—August 31st, 1902.

Penalty for Late Completion.—One per cent. of value of contract per week.

Specified Terms of Payment.—Up to 75 per cent. of work executed on site by monthly payments until balance of 25 per cent. of executed work equals 10 per cent. of total contract sum. Thereafter 90 per cent. of work executed till work is completed. A further 5 per cent. to be then paid and balance of 5 per cent. 12 months later.

Period of Maintenance.—12 months from date of completion.

Stipulations as to Removal of Foreman.—Satisfactory.

Stipulations as to Wages Paid to Workmen.—Standard rates to be paid.

Amount of Sureties.—To be stated in tender.

Arbitration Proposals.—Satisfactory.

Date for Receipt of Tenders.—January 24th, 1902.

Mr. A. Hugh Seabrook, A.M.I.E.E., the engineer and manager to the Barking municipal electricity supply undertaking, is responsible for the preparation of this specification. In our issue of June 14th last, when examining a previous specification issued by Mr. Seabrook, we commended him for the manner in which the technical requirements were stated, tenderers being given a free hand in regard to the methods they propose to meet his wants.

In the present case the same course has been adopted, and we are sure that the Council will benefit by the sensible methods thus pursued by their technical adviser.

A good deal of discussion has recently taken place in our columns on the advisability of combining in one section the engine and dynamo which together form the steam dynamo. In the case of large sets, we are strongly in favour of giving separate contracts to engine and dynamo manufacturers, but for high speed sets of the size now required, viz., 250 KW., it may be that not so much advantage is gained by separating the engine and dynamo, and thus dividing the responsibility. The date of completion, viz., August 31st next, is fair and reasonable, and the general conditions are largely based upon those agreed upon between the Electrical Plant Manufacturers' Association and the Municipal Electrical Association.

LIGHT RAILWAYS.

List of Applications made to the Light Railway Commissioners in November, 1901, for Orders authorising Light Railways.

Title.	County.	Promoters.	Engineer.	Mileage	Motive power.	Gauge.	Agents.
ENGLAND.—						Ft. in.	
1. Accrington and Burnley ...	Lancaster.	Auxiliary and Light Railways & Tramways Co., Ld.	C. Chadwell ...	4¼	Electric	4 0	Tahourdins and Hitchcock.
2. Ashby, Swadlincote and Burton	Leicestershire, Derbyshire, and Staffordshire.	T. Hall, W. H. Buckley, R. Lawton, and W. J. Kershaw	C. H. Gadsby ...	11	Electric	3 6	Baker, Lees and Co.
3. Barnsley and Doncaster ...	Yorkshire.	Sir Henry Wood, T. Mitchell and W. H. Chambers	Preece & Cardew and J. N. Shoolbred ...	16¼	Electric	4 8½	Rees & Frere.
4. Canterbury and Herne Bay	Kent.	O. W. Bowen and W. J. Kershaw	Pritchard, Green and Co.	11	Electric	3 6	J. D. Tetley & Co.
5. Cheltenham and District (extensions)	Gloucestershire.	Cheltenham and District Light Railway Company	E. Dodd	6¾	Electric	3 6	Winterbothams and Gurney
6. Clacton-on-Sea and St. Osyth	Essex.	T. Lilley, S. J. Stiff, G. Riley and others	J. Russell	4½	Electric	4 8½	Burchell, Wilde and Co.
7. County of Hertford (Barnet) No. 2	Hertfordshire.	Hertfordshire County Council	V. B. D. Cooper ...	2	Electric	4 8½	R. A. Read, jun.
8. County of Hertford (Bushey) No. 3	Hertfordshire.	Hertfordshire County Council	V. B. D. Cooper ...	2¼	Electric	4 8½	R. A. Read, jun.
9. County of Middlesex (Enfield extension)	Middlesex.	Middlesex County Council	H. T. Wakelam ...	1¾	Electric	4 8½	Sherwood & Co.
10. Crystal Palace	London and Surrey.	Crystal Palace Light Railways & Tramways Co., Ltd.	V. B. D. Cooper ...	2½	Electric	4 8½	Bennett and Chance.
11. Derby and Nottingham ...	Derbyshire and Nottinghamshire.	Sir James Mackenzie, Bt., J. Fell, and W. J. Kershaw	C. H. Gadsby ...	14½ 5½	Electric	4 8½ 3 6	Ashwell and Tutin.
12. Derby, Nottingham and District	Derbyshire and Nottinghamshire.	Sir Bache Cunard	B. Peyton Legare ...	24½	Electric	4 8½	J. Kennedy.
13. Doncaster Corporation (deviation and extension)	Yorkshire.	Doncaster Corporation ...	W. H. R. Crabtree ...	⅛	Electric	4 8½	Sherwood & Co.
14. Dover River and Alkham Valley	Kent.	Sir Wm. Crundall, R. Tritton, G. Clark, and A. Clark	W. T. Pressland and Mark Parker	2¼	Electric	3 6	Mowll & Mowll.
15. Dover, St. Margaret's, and Martin Mill	Kent.	Sir W. Pearson, Sir J. Jackson, and Sir Wm. Crundall	W. T. Pressland and Mark Parker	5	Electric	3 6	Mowll & Mowll.
16. Dudley and Rowley Regis ...	Worcestershire and Staffordshire	Dudley Corporation and Rowley Regis U.D.C.	R. P. Wilson ...	10¼	Electric	3 6	Sharpe & Co.
17. Erewash Valley	Derbyshire and Nottinghamshire.	Sir Bache Cunard	B. Peyton Legare ...	18	Electric	4 8½	J. Kennedy.
18. Grimsby and Saltfleetby (amendment)	Lincolnshire.	Grimsby and Saltfleetby Light Railway Company	——	Extension of time and power to issue preference shares.			W. H. Smith and Son.
19. Halesowen	Worcestershire.	Halesowen Rural District Council	W. Whitworth ...	1¾	Electric	3 6	Baker, Lees & Co.
20. Hounslow, Slough & Dachet	Middlesex and Buckinghamshire.	Metropolitan District Electric Traction, Co., Ld.	Sir Alex. R. Binnie	12	Electric	4 8½	G. D. Perks.
21. London and S.-Western Railway (Bentley and Bordon)	Southampton.	London and South-Western Railway Company	W. R. Galbraith and J. W. J. Hood	4¾	Steam	4 8½	S. Bircham.
22. London United Tramways (Light Ry. Extensions) No. 2	London and Middlesex.	London United Tramways, Limited	J. Clifton Robinson	12½	Electric	4 8½	Sherwood & Co.
23. Luton, Dunstable and District	Bedfordshire.	J. Fell, W. J. Kershaw, and C. Osborne	Pritchard, Green & Co.	10	Electric	4 8½	Wm. Webb & Co.
24. Mansfield & District (extensions to Belper & Ilkeston)	Derbyshire and Nottinghamshire.	Mansfield and District Light Railway Company	A. Dickinson & Co....	21¾	Electric	3 6	Ashwell & Tutin.
25. North Lindsey (amendment)	Lincolnshire.	North Lindsey Light Railway Company	L. B. Wells	¼	Steam	4 8½	W. Dodgson.
26. North Shields, Tynemouth and District (extensions)	Northumberland.	Tynemouth and District Electric Traction Co., Ld.	S. Sellon	½	Electric	3 6	S. Morse.
27. Nottingham Suburban ...	Nottinghamshire.	Sir James Mackenzie, Bt., J. Fell, and W. J. Kershaw	C. H. Gadsby ...	11	Electric	4 8½	Ashwell & Tutin.
28. Poole & District (extensions)	Dorsetshire.	Poole and District Electric Traction Co., Limited	S. Sellon	1¾	Electric	3 6	S. Morse.
29. Preston and Horwich ...	Lancaster.	Sir J. Mackenzie, Bt., G. Hunter, J. Harlick, and C. Osborne	C. Chadwell ...	23¼	Electric	4 8½	Tahourdins and Hitchcock.
30. Preston and Lytham ...	Lancaster.	Sir J. Mackenzie, Bt., G. Hunter, J. Harlick, and C. Osborne	C. Chadwell ...	9¼	Electric	4 8½	Tahourdins and Hitchcock.
31. Ramsbottom, Edenfield, and Rawtenstall	Lancaster.	C. L. Bovet, J. Thornton, and A. Want	J. H. Rhodes ...	5¼	Electric	4 8½	E. W. I. Peterson
32. Selby and Goole	Yorkshire.	R. Creyke, G. Stubley, A. F. Hood, and others	W. B. Myers Beswick & R. Elliott Cooper	13½	Steam	4 8½	Baxter & Co.
33. Southend (and District), Bradwell-on-Sea, & Colchester	Essex.	Railway and General Construction and Maintenance Company, Limited	M. Noel Ridley ...	34¾	Electric	4 8½	Spencer, Cridland & Co
34. South Norfolk	Norfolk.	Sir R. Beauchamp, Bt., N. H. Bacon, and others	——	Extension of time.			Copeman & Cadge
35. Torquay and Paignton ...	Devonshire.	Provincial Electric Supply and Traction Company	Pressland & Fippard	10	Electric	3 6	E. W. I. Peterson
36. Tottenham & Walthamstow	Middlesex & Essex	Metropolitan Tramways and Omnibus Co., Ltd.	S. Sellon	7¼	Electric	4 8½	H. C. Godfray.
37. Wakefield and District (Dewsbury and Castleford extensions)	Yorkshire.	Wakefield and District Light Railway Company	Pritchard, Green and Co.	25	Electric	4 8½	Wm. Webb & Co.
38. Walthamstow and District (Urban District Council)	Essex and Middlesex.	Walthamstow Urban District Council	G. W. Holmes ...	10¾	Electric	4 8½	Wm. Webb & Co.
39. Warrington Corporation ...	Chester.	Warrington Corporation ...	Preece & Cardew ...	1¾	Electric	4 8½	Baker, Lees & Co.
40. Watford and District ...	Hertfordshire.	Watford and District Tramways Company	Pritchard, Green and Co.	6½	Electric	4 8½	Warwick Webb & Wm. Webb & Co.
41. West Manchester (extension and amendment)	Lancashire.	West Manchester Light Railways Company	W. B. Myers Beswick	1¼	Steam or Electric	4 8½	Torr & Co.
42. Windsor and Maidenhead ...	Berkshire.	Metropolitan District Electric Traction Company, Limited	Sir Alex. R. Binnie...	12¼	Electric	4 8½	G. D. Perks.
WALES—							
43. Glamorgan County Council (Morriston to Pontardawe)	Glamorganshire.	Glamorgan County Council	E. S. Sinnott ...	5¾	Electric	4 8½	Baker, Lees & Co.
44. Llandudno and Colwyn Bay (deviation and amendment)	Denbighshire.	Llandudno, Colwyn Bay, and Rhyl Electric Traction Company, Limited	Hewitt & Rhodes ...	—	Electric	3 6	Warwick Webb.

Light Railway Commission, *December 1st*, 1901.

ALAN D. ERSKINE, *Secretary.*

ELECTRICAL PROGRESS AND LEGISLATION: THE NEED OF REVISION.*

BY R. PERCY SELLON, M.I.E.E., Chairman of the Electrical Trade Section of the London Chamber of Commerce.

(*Concluded from Vol.* 49, *page* 1074.)

IV.

WHATEVER may be the balance of public gain or loss in the outworking of this policy in general, so far as its application to the electrical industry is concerned it has proved a failure. There is exception to every rule; and even if the doctrine of common ownership by a community of the agents responding to its needs be justifiable as a working hypothesis in most cases, it was inevitable that it should break down in that of electrical science. Sewerage, water supply, public parks, markets, golf-links, burial grounds, even the bread and the milk supply which some local authorities crave the right to embark upon, are in the nature of undertakings which demand no exceptional expert knowledge for their conduct, and are subject to no such vicissitudes of change and development as confronted the electrical industry in the seventies and eighties, and for that matter still confront it. Encouragement to prove its capabilities, liberty to improve its methods and systems and to test its merits against existing modes of communication, lighting, heating, supply of power, and locomotion, this was the treatment which public interest demanded for electrical science, and which other countries afforded; with results now generally known.

A brief glance at the history and special features of electrical legislation reveals the following:—

ELECTRIC LIGHTING ACT, 1882 AND 1888.

The Electric Lighting Act, 1882, purported to be a measure for "facilitating," but until amended by the Act of 1888 proved practically fatal to the introduction of electricity supply. Its leading provisions are:—

"(*a*) That the right to introduce electricity supply into an area shall be subject to the consent of the local authority.

"(*b*) That if introduced, the undertaking shall be purchaseable by the local authority at the expiration of 21 years at the then market value of existing buildings, plant and mains, without any consideration in respect of good-will and loss of prospective profits."

What followed is so generally known that I need not dwell upon it at length. Although some 54 provisional orders were promptly applied for and granted by the Board of Trade, capital could not be raised on the terms of the Act to give effect to them, and only one of them passed from the stage of concession to actual works. Hence for the next six years practically nothing was done at home, while in the United States some 120 electric lighting stations, paying dividends of 6 to 14 per cent., and numerous undertakings in Germany, Switzerland, and Italy, were established.

Then followed the agitation for the Amendment Act of 1888, which increased the tenure to 42 years. But the seeds of mistrust sown in the investor's mind by the earlier Act proved difficult to eradicate, and, in point of fact, they have never since wholly died out. Gradually an industry of electricity supply was fostered by the efforts of pioneers, but the status and terms of expropriation granted by the Acts to local authorities still interpose an obstacle to the free expansion of electricity supply by private enterprise. Of a total of some 438 provisional orders granted to the end of 1900, 366 are in the hands of local authorities and 127 of private enterprise; of the latter, about 90 per cent. have been proceeded with, but of the former nearly two-thirds are still in abeyance.

In many other districts electricity supply is unobtainable, because the local authorities own the gas undertakings and refuse consent; or, because they demand, as the price of consent, special terms, such as reduced tenure, free public lighting, or the like, thus defeating the intention of the Acts which have laid down what, in the opinion of Parliament, constitutes fair consideration for the right to break up the public streets.

TRAMWAYS ACT, 1870, AND LIGHT RAILWAYS ACT, 1896.

It is pertinent to ask why, in the United States, there are at present some 15,000 miles of electric tramways, and in Great Britain not 500, although considerations of density and distribution of population would appear to point to the latter rather than to the former country as the natural locus for electric traction enterprise. No one acquainted with the facts will deny that this anomaly is traceable to the Tramways Act, 1870, by which statute electric traction found itself governed and controlled for nearly two decades. The Act clearly contemplated horse tramways exclusively, and the boundaries of a single local authority as the scope of the undertaking. Under its provisions a certain mileage of horse tramways was organised; but, as a directive force on electric traction, it has proved a failure. Less than 50 miles of electric traction were carried out in Great Britain until the passing of the Light Railways Act, 1896, although during this interval some 10,000 miles had been introduced in the United States.

Thus in the sphere of electricity supply and electric traction alike, many years were lost before a start was made. During these years our foreign rivals, unhampered, as I shall show later, by restrictive legislation, laid the foundation of the superstructure of discovery and organisation of manufacture which has enabled them not only to supply their own territories, but overflow into ours.

The reason for this is not far to seek. So far as existing horse tramways were concerned, the period when they might be expropriated by the local authority was at the date of the advent of electric traction in most cases approaching; and undertakers had no inducement to reconstruct the roads and equip them for electric traction, with the knowledge that in a few years' time they would revert to the local authority. Again, there was for some time strenuous and unreasoning opposition, even in rural districts, to the use of the overhead trolley system, in spite of the fact that this system was in extensive operation in other countries without public disadvantage. As regards new lines, there was, on the one hand, the constantly exerted veto of the local authorities, and on the other the mistrust of electrical enterprise engendered by the Electric Lighting Acts, and the consequent inability to secure capital. To crown all came the House of Lords' decision confirming the arbitration awards by Sir F. Bramwell, whereby Sec. 43 of the Act was held to mean that local authorities may, at the end of 21 years, compulsorily purchase a private tramway undertaking at the bare value of its works and plants at the date of purchase.

The most objectionable features of the Tramways Act are:—

(*a*) Absence of compulsory powers for the taking of land.

(*b*) The frontager's right of veto under certain conditions.

(*c*) The veto of the local and road authorities.

(*d*) The limitation of tenure to 21 years, and the terms of expropriation by the local authorities above referred to.

It was believed at the time of the passing of this Act that the objectionable innovation of the purchase clause would not deter investors, inasmuch as the Act did not limit profits. This in a sense proved true, but also greatly to the public disadvantage, since promoters either secured themselves by earning quick profits by flotation of tramway enterprises at inflated capital values, or confined the lines to a few main streets in big cities and charged heavy fares. These courses were not consistent with the public interest, and promotions under the Tramways Act soon incurred a degree of odium which passed as an unpopular heritage to electric tramway enterprise. It was clearly the intention of Parliament at the time of the framing of the Act that the consent of the local authority should take the simple form of saying "yea" or "nay" to tramways in its locality; but the powerful lever of the veto has been increasingly used to extort from promoters, as the price of consent, terms which the Act never contemplated, *e.g.*, annual rent for the right of user of the streets, and other exactions. Finally, the difficulties connected with the consents and purchase clauses became so complicated in the case of tramways traversing the areas of several local authorities, that something approaching a deadlock ensued until the passing of the Light Railways Act, 1896, partially relieved the situation.

The Light Railways Act, 1896, introduced for a term of five years (since renewed until the end of 1902), modified some of the most objectionable features of the Tramways Acts, by securing improved tenure, facilitating tramway networks over areas controlled by two or more local authorities, providing machinery for local inquiry and grant of powers with the approval of the Board of Trade, and by dispensing with the consent of the local authorities concerned where a clear case in favour of the suggested tramways can be established.

Under this Act substantial progress has been made in introducing electric traction projects, both in the nature of tramways of an inter-urban and cross-country character. The experimental procedure laid down has worked well, the system of local inquiry by the Light Railway Commissioners having resulted in expeditious and not unreasonably costly procedure, while affording all parties opportunities of presenting their views.

But this Act expires as above mentioned at the end of 1902, and there is reason to believe that strenuous efforts will be made in certain quarters to prevent its renewal, or at any rate to restrict its application to light railways as distinct from tramways. The deep-rooted mistrust of electrical enterprise by investors already referred to, due to the disastrous provisions of earlier legislation, is still operating prejudicially against any such progress in electric traction at home as is taking place abroad; and as any reversion by Parliament to less favourable conditions than the Act now provides will give a check to returning confidence from which the public will be the greatest sufferers, it may be hoped that a measure will be forthcoming at an early date, extending the provisions of the Light Railways Act, making the Board of Commissioners a permanent body, repealing the objectionable Tramways Act, and bringing procedure as to tramways proper under its provisions.

The consequences of the Electric Lighting and Tramways Acts upon the manufacturing industry in Great Britain may be judged from the fact that the capital engaged in electrical plant production in Great Britain is less than one-fifth of that in Germany, and one-tenth of that in the United States: while the system of heterogeneous specifications under which local authorities have purchased their requirements has made standardisation and specialisation practically impossible. Out of a total of some 298,000 H.P. of steam engines, and 200,000 KW. capacity of dynamo generators now in use for electric lighting and traction purposes in Great Britain, some 73,000 H.P. of the former and 71,000 KW. of the latter have been of American or German manufacture, while in the year 1899 the imports of electrical machinery doubled the exports.

In his presidential address before the International Engineering Congress at Glagow this summer, Mr. James Mansergh is reported in the *Times* of September 4th as follows:—

"He feared that only too good a case could be made out for the allegation that a mistaken statutory system had discouraged in this country—for the time being, at least—the naturalisation and development of electrical engineering on the largest scale. Instead

* An address delivered before the London Chamber of Commerce, Wednesday, December 18th, 1901.

Light Railway Commission, *December 18, 1901.*

of the electrical and mechanical development of lighting and power plant being undertaken in this country upon a scale proportional to its early promise, the work had to be done by samples, every small specimen differing from the others. Meanwhile our friends in America and on the Continent were forging fast ahead. So we lost our chance, and probably should have to take other people's electrical plant for some time, instead of striking out our own leading line as our less governed forefathers did in railway work and shipbuilding, years ago."

V.

So far the history of electrical legislation and the position created by it. That which it is now important to realise is that we are on the eve of developments which constitute a new situation.

Discoveries and technical advance in recent years have rendered commercially possible the economical distribution of electrical energy over very large districts, amounting to many hundred square miles. Electrical power distribution schemes, comparable in magnitude and importance with those at Niagara, Rheinfelden, Geneva, and Silesia, have been authorised by Parliament for many of our centres of industry, such as Lancashire, Durham, South Wales, the Midlands, and North London, and a commencement of works has in some cases already been made. It is also becoming generally recognised that electric traction is the master key to the solution of the problem of congestion of population and the housing of the working classes, by the facilities it promises to afford for cheap and rapid transit from industrial and commercial foci to the country districts around them. The scientific interest attaching to these developments is as nothing to their profound social and industrial significance. They mean that electrical energy need no longer be generated in the midst or on the fringe of crowded cities, but at the pit's mouth, where fuel, land, and labour are cheapest, and smoke and dirt nuisance reduced to a minimum; and that its quantitative production and extended uses will enable it to be sold at a price within the reach of all for lighting, heating, locomotion, and motive power. Changes of a far-reaching character must inevitably follow. The necessity of herding masses of the working classes together into urban areas in order to conduct industry advantageously, at present the despair of statesmen and social reformers, will disappear, not only because cheap traction will enable them to get away during their leisure and sleeping hours, but because it will be more profitable to erect factories away from the cities than in them.

To govern the novel conditions which will thus be created, amendment of existing legislation is indispensable. It has been pointed out that the extension of the Light Railways Act expires in December, 1902, and it is impossible, after the proved failure of the Tramways Act to do justice to electric traction, that the latter will be allowed to remain on the Statute Book as the medium by which such enterprise must be regulated.

In the course of his evidence before the Municipal Trading Committee, the Earl of Morley, Lord Chairman of Committees, stated:—

"The Tramways Act of 1870 was designed to meet an entirely different set of circumstances from the present. . . . . I think a tramways Bill is very much wanted indeed, and I am all for the local authorities having a mandatory standing order that they should be heard in any way they like before committees, but I think by giving them an absolute power to stop a Bill, they may stop a very useful enterprise, whether it is conducted by a company or by a neighbouring municipality, and also it gives them the power of imposing conditions which are very often extremely onerous. . . . . The whole question of the length of period of purchase is one that ought to be considered now, because nowadays the laying of electric tramways and providing generating stations and so on, is so enormously more costly than it originally was in the case of horse tramways. I think it is a question that certainly deserves the consideration of Parliament."

As regards electricity supply, the Power Distribution Acts of 1900, and since, afford evidence that the Legislature is beginning to realise that the progress of electrical science must not be wholly sacrificed to the theories which prompted the earlier legislation. But these Acts still make the consent of local authorities a condition precedent to the supply of electrical energy, and fail to stipulate that such consent shall not be unreasonably withheld, or that it shall be withheld only in the event of the local authority undertaking to furnish its own supply at a reasonably early date and under reasonable conditions.

Before the Municipal Trading Committee, Mr. Albert Gray, counsel to the Lord Chairman of Committees in the House of Lords, said, in reply to a question as to the effect of the Local Authority Veto on schemes under the Tramways and Light Railways Acts:—

"I am bound to say at the present time it appears to me to work extremely badly. My view is that it was the intention of Parliament that the consent of the local authority should be what we may call a clean consent; it should exercise discretion as to whether or not tramways should be introduced into a town, or into the particular streets of a town; and if it were so exercised, there would be no objection to it. But there has sprung up, unfortunately, a practise of demanding conditions by local authorities when their consent is asked for, and these conditions amount now in some cases to the demand that the local authority shall share the profits of the undertaking during the period which Parliament has given as the term of the company's tenure. . . . . I think it extremely bad form for members of these Councils, and especially for their officers, to have to carry on business of this kind—that is to say, haggling over the conditions on which the consent is to be given. I do believe that it probably must lead to corruption in some form or other."

The development of electric supply and traction within the next 10 years or so may be expected, if afforded a fair field, to engage an amount of capital which, at a modest computation, may be estimated at £250,000,000 sterling. It is therefore pressing that the Legislature should at this juncture determine whether this development and this expenditure shall be entrusted to municipal or private enterprise.

If to municipal enterprise, then this capital responsibility, taken in conjunction with expenditure on the numerous other enterprises already referred to on which local authorities are entering, must pile up the total of local indebtedness to a figure largely exceeding the National Debt. It must also have the effect of diverting their attention from those social and sanitary problems which should be the first object of their solicitude; while the gigantic bureaucratic system which would thus be created may well give pause to the most enthusiastic advocate of collectivist dogma. History has a knack of repeating itself, and we do not need to turn back many pages of our history to reach the chapter when trade guilds, the predecessors of our local authorities, so monopolised and restricted all trades and industries within their borders that drastic statutes were found necessary to restore trade and commerce to the state of freedom and prosperity from which it had been diverted by the abuses to which the prevailing system had led.

A consideration to be borne in mind in connection with this question is that under coming developments the boundaries of individual local authorities will no longer embrace the undertakings from which electric supply and traction are obtained. The economical area for either of these purposes must be determined independently of local government boundaries, by such considerations as facilities for obtaining fuel and other materials; distribution of population; character and location of trades and centres of commerce, &c. The moment that a local authority undertakes supply of electrical energy or electric traction outside its own borders, it crosses the Rubicon which divides the rendering the service to its own ratepayers by the aid of their capital from the functions of an ordinary trading concern. In his evidence before the Joint Select Committee on Municipal Trading last year, the late Sir Courtenay Boyle, Permanent Secretary to the Board of Trade, stated as follows:—

"The effect of allowing local authorities to supply outside their own districts, naturally makes the local authority a trading company outside its own district. If it loses, its ratepayers lose for the benefit of the district; if it gains the ratepayers gain at the loss of the people in the district; so that the local authority does become a trading company outside its own district. . . . We are very much concerned to know what Parliament thinks ought to be done as regards applications from municipalities to go outside their own areas, whether for electric lighting or for gas or for tramways."

The fact that in the Session of 1900, 22 local authorities applied for powers to distribute electricity, and 23 to conduct tramways, outside their area, 36 to manufacture and supply electric fittings, and 19 to construct dynamos and steam engines, is evidence of the momentum which the municipal trading movement has acquired unknown to most of those whom it most deeply concerns.

I desire again to disclaim any intention of making an attack on municipal activity as such, or to appear to depreciate the splendid results which have attended the efforts of some great corporations to improve the material and moral condition of their communities. No one who has come into contact with municipal government in foreign countries can fail to appreciate the favourable contrast which is presented by the high standard of civic duty, the ability of members and officials, and the organisation and conduct of affairs in our great cities, compared with those prevalent in many high places abroad. My contention is that whatever may be the dividing line between legitimate and illegitimate functions of local authorities, that of fostering a novel, changeful, and undeveloped agent such as electricity in the service of man is not, and ought never to have been, treated as within the former category; and that the unwisdom of continuing so to treat it, having regard to the developments which are now imminent upon us, will attain to the dimensions of a national calamity.

VI.

It is worth while to glance at the history and practice of foreign countries in relation to electrical legislation.

In the United States the Federal Government has not attempted to direct or control the development of electrical science by legislation. Some of the States have enacted laws of an unrestrictive character, but in general the industry has been unfettered both by socio-political doctrines or departmental regulations.

Municipal electrical enterprise is in strong disfavour, for the grave abuses which attended the participation in past times by local authorities in public services and trading undertakings, have led to a reaction, and brought about legal limitation of municipal debt, and a tendency to confine such enterprise to water supply, as being consistent with those sanitary obligations which are the undisputed duty of local authorities. It is noteworthy also that both the telegraph and telephone are in the hands of private enterprise, and appear to give general satisfaction, the telephone service being organised and used on a scale unknown in this country. Technical regulations affecting the industry do not emanate from Federal or State Departments as with us, but conform to a code laid down by the National Board of Fire Underwriters in consultation with electrical experts.

In Germany, also, there is no direct State control or direction of electrical enterprise, the commercial aspects of electrical undertakings being left to the authorities of individual States or boroughs, while technical or constructional details are maintained in general conformity with advisory regulations issued by the German Institution of Electrical Engineers. A large and increas-

ing volume of electrical works has been carried out by local authorities, but there is not the same tendency to block private enterprise in cases where the municipality is unable or unwilling to do the work itself.

In Switzerland and France, on the other hand, legislation and departmental regulations play a large part in controlling and directing the course of electrical enterprise. In both countries a department or commission, recruited partly from Government officials and partly from representatives of the electrical engineering institutes and prominent persons connected with the industry, is provided for, with the object of advising the Government on legislative questions affecting the industry, and compiling and revising from time to time regulations for its guidance.

This prompts the observation that the absence in Great Britain of an analogous organisation to confer with the Government, the Board of Trade, the Home Office, and other State Departments on legislation and regulations affecting the electrical industry is a defect in our machinery. Statutes and bye-laws issue from Government officials who, however capable and desirous as they have always proved themselves to be of doing justice to the industry, are necessarily out of touch with the financial, industrial, and technical conditions under which its welfare, consistently with the public advantage, can be secured.

It would appear practicable and desirable that a standing committee should be appointed under the auspices of the Institution of Electrical Engineers, strengthened by representative experts from Chambers of Commerce, and other interests concerned, to which Government and State Departments could and would turn for consultation or advice when framing or amending statutes or regulations.

Under the present system laws once enacted remain inflexible until an overwhelming body of evidence can be produced pointing to the desirability of amendment. The preparation of such evidence depends upon vicarious effort from time to time by individual interests immediately aggrieved, and if these interests happen to be incapable of presenting a forcible case, matters remain unaltered or critical precedents created without appreciation of their bearing and importance to the public and the industry. At no time in the history of electrical progress has careful discrimination been more imperative than now when the future of telephony, wireless telegraphy, bulk power distribution schemes, and electric tramways and railways, hangs in the balance.

I am far from advocating the indiscriminate adoption of either American or German methods. It has yet to be proved that gigantic combinations controlling an entire industry on the American model are in the interest either of the public or the industry concerned. The violent reaction which has followed a period of over-production and over-trading in Germany, encouraged by an elaborate system of industrial banking, may well cause us to be thankful that British conservatism has at any rate saved us from a like catastrophe. But it is not necessary to cripple an industry by legislation in order that it shall not over-reach itself and prejudice the public weal by organisations tending towards monopoly or towards over-production. British methods have ensured that what little has been done has been done well, with freedom from violent industrial dislocation, but the application of legislative swaddling clothes has so atrophied the infant industry that it is threatening to render impossible the ultimate recovery which is at any rate possible in the case of too rapid growth.

Attention must be called to another feature of the situation, namely, its effect upon original work. During the first half of the last century, the era of research and discovery which led to the telegraph, the submarine cable, and the dynamo, British inventors were in the forefront, and, indeed, to them the world largely owes these advances. But to foreign inventors is almost wholly due the developments of the latter half of the century—the telephone to Bell, Edison and Elisha Gray in the United States; alternate current distribution to Gaulard, Zipernowsky and Blathy; electric traction to Field, Edison, Daft, Bentley and Knight, Sprague and others in the United States; the telautograph to Elisha Gray and Foster Ritchie; polyphase distribution, making transmission of energy over large areas possible, to Ferraris, Tesla, Dolivo-Dobrowolsky, and Brown; high-speed telegraphy to Pollak and Virag; and wireless telegraphy to Marconi.

Is it an accident that electrical discovery in England waned coincidently with the legislation which retarded the electrical industry in Great Britain? I venture to think that there is a direct relation between the two, and that the falling off of invention in the electrical field is neither due to accident nor decay of the originative faculty among Englishmen, since in other industries the records of the Patent Office show that it has been fully maintained; but that it is traceable to the depressing effect produced by departmental and official environment arising out of the policy of the Legislature, depriving invention of hope of recognition and stimulus of reward.

VII.

In no other prominent industrial country, then, has the electrical industry been subjected to a decisive bent through premature legislation—an experiment which has turned out unfortunate in Great Britain, not only in retarding progress, but in creating a deep-rooted mistrust of electrical enterprise which has dammed the flow of British capital even into those channels with which the Legislature has not interfered.

How far the error of past policy may be retrieved by more liberal treatment, by allowing greater freedom for natural development, by increased inducements to discovery, manufacture, and capital to combine for ends which all admit to be of great social advantage, is open to question. A bad start has been made, rivals are ahead in the race. But there is ground for high hope that the industrial talent of our countrymen, though threatened for a season by the precocious rush of foreign expansion in a sphere which it had come to regard as its own, will, with the unparalleled resources of the British Empire behind it, enable us to maintain that position as an industrial country on which our future depends. This hope is justified by the consideration that the essential and material causes of our past ascendency still remain; the personal and preventible factors alone need readjustment to the changed conditions.

The position has been summed up by Mr. William Langdon in his recent presidential address before the Institution of Electrical Engineers, in terms which cannot be improved upon:—

"The question we have to approach is one of enormous magnitude. It is not merely one of business or one of interest from an electrical point of view, but one which, inasmuch as it affects the moral and physical welfare of a great portion of the community, must sooner or later affect our national welfare.

"Electricity is but treading on the fringe of that vast domain it is destined to serve. . . . . It is only now in the establishment of the power schemes, destined to serve large areas, that we are approaching those economical conditions which will confer upon the Commonwealth its full advantages. . . . . We see that in the establishment for furnishing to those that need it the power which is to aid in this economical commercial propaganda, other lands are in advance of us—that we are only now awakening to the means by which it is given us to compete in the race. . . . . If the establishment of these power schemes is to be of that service to our industries which may fairly be anticipated, it is of the greatest importance that they should receive at our and other hands all the aid in our power."

In conclusion, the considerations advanced in this paper may be summarised as follows:—

(*a*) The practical development of the electrical industry in Great Britain is in arrear of other leading industrial countries.

(*b*) This is mainly traceable to the policy adopted by the Legislature of favouring State and municipal enterprise to the exclusion of private enterprise.

(*c*) This policy has hitherto had the effect of discouraging capital, checking invention, and dwarfing manufacture.

(*d*) A new era of cheap electricity supply for industrial purposes, and increased facilities for suburban and interurban communication by means of electric traction, is upon us; offering a promising solution of the problems of congestion in towns and the housing of the working classes.

(*e*) Existing legislation is restrictive of this development so far as it is applicable, and inapplicable where it is not restrictive.

(*f*) Amended legislation is therefore desirable, and this should clearly define what is to be the future relation of municipal enterprise towards the electrical industry.

(*g*) It is desirable that a Standing Committee or other body representative of the electrical industry should be created, with whom Government and State Departments should confer when framing or amending legislation or regulations affecting the industry.

THE BATTEN PATENT RECTIFIER.

THE idea of commutating alternating current by means of a synchronous vibrating armature is probably nearly as old as the alternating current system itself, and the mechanical synchronisation is a remarkably easy problem to solve. Any polarised relay that is at all well made will respond to alternations of current of a much higher frequency than the highest commercial rate at present in use. A more widely known instance of the same principle is the magneto bell of telephone fame, which, with a little careful adjustment, can be made to ring continuously off an alternating current system.

Prof. Vilard, of Paris, has done much work along these lines by setting a tuning-fork in motion, such tuning-fork having a vibration rate approximately equal to the alternations, the elasticity of the fork amplifying the vibrations by isochronism of its period until considerable amplitude is obtained.

Up to the present, however, the excursions of the vibrating tongue, or reed, have, by the necessity of the effect following the cause, lagged in phase behind the alternations of E.M.F. that cause the current which drives them, with the result that the reed does not commence its movement in any period until the E.M.F. has risen to a considerable portion of its ultimate value, and a spark takes place at the point where the circuit is broken, which spark is inimical to the successful commutating of alternating curren tsby these means. In the "Batten" rectifier, the instrument under review, the effect is made to precede the cause, so to speak, in two ways.

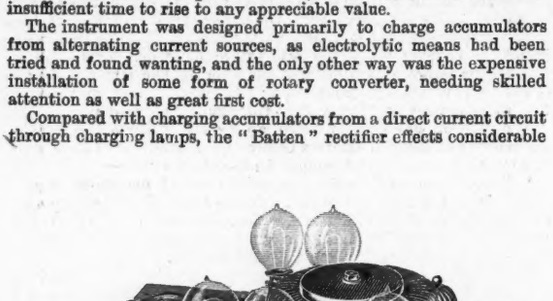
The current driving the armature is taken direct from the mains, through a lamp which reduces the current to an amount not more than sufficient for the purpose. The primary of a small transformer is also connected to the above-mentioned mains, the secondary of the transformer providing the current to be rectified.

It thus happens that the lag in phase of the secondary current behind the primary current compensates for the lag in movement, due to the mechanical inertia of the armature, and the small self-induction of the driving electro-magnet. In practice the lag in the transformer is not quite sufficient for the purpose, but to "tune up," a condenser is put across the terminals of the lamp in the driving circuit, and the result is, that no spark whatever occurs, even with a load of 6 amperes, as the contact is made and broken at equal periods on

either side of the zero potential line, so that the E.M.F. has had insufficient time to rise to any appreciable value.

The instrument was designed primarily to charge accumulators from alternating current sources, as electrolytic means had been tried and found wanting, and the only other way was the expensive installation of some form of rotary converter, needing skilled attention as well as great first cost.

Compared with charging accumulators from a direct current circuit through charging lamps, the "Batten" rectifier effects considerable



THE BATTEN RECTIFIER.

economy in energy, as the transformer brings down the secondary or charging voltage to an amount not more than sufficient for the needs of the accumulator being charged, and a switch, giving a range of voltages, can be easily fitted where necessary.

Consider a 10-volt accumulator battery. On a direct current circuit of, say, 100 volts, 90 per cent. of the energy is thrown away in heating the charging lamps, but with the "Batten" rectifier the voltage is transformed down to, say, 15 volts, and making a liberal

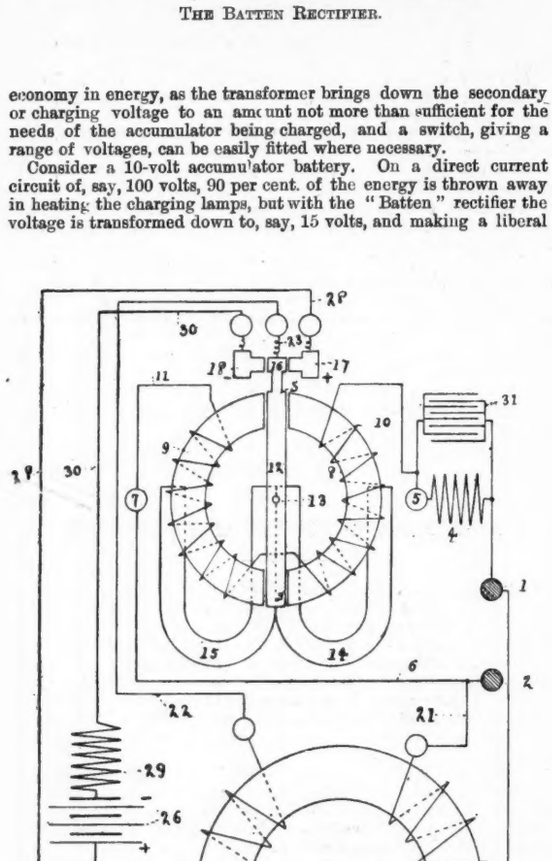


DIAGRAM OF CONNECTIONS.

allowance for transformation and other losses of 5 per cent. on the 100 volts, the difference would be a loss of 5 in 20 as against 90 in 100.

The machine will also drive small motors, and perform a variety of electro-therapeutical duties.

The diagram of its connections is self-explanatory, 1 and 2 being the alternating mains, while the apparatus itself, as manufactured by the General Electric Company, of Queen Victoria Street, is shown in the preceding figure ready for work.

THE DYNAMO AS AN ADJUNCT TO THE BLAST FURNACE.

BY HORACE ALLEN, C.E.

BLAST furnaces for the manufacture of iron are being increased in dimensions and output to such an extent that any accidental interruption to either the supply of air blast or the regular working conditions involves a considerable loss, either through reduced production or inferior quality of product.

At Youngstown (Ohio) the National Steel Company have a furnace 106½ ft. high, with a bosh 23 ft. in diameter, and hearth 15 ft. diameter, which is designed to produce 600 tons in 24 hours. With such a furnace it will be readily comprehended that any accident causing the quality of the iron to be inferior to that required, or the output restricted, must mean very heavy loss, and any means that can be applied to considerably shorten the time required to remedy the defect must be of extreme importance to the ironmaster. The electric current can now be applied in a number of instances, and a few applications may be described with advantage.

The continuous perfect working of the blast furnace is dependent upon the supply of air blast from the blowing engine, and among other cases of the economical application of the electric arc may be mentioned the repair of a fractured connecting rod; in the case in point the forging of a new connecting rod, with machining and fitting, would in the ordinary way have occupied some days, while by means of the electric arc the end was welded on again, the operation occupying hours in place of days.

In all blast furnace installations there should be an electric plant, the output of which would, of course, be controlled by the possibilities of application.

It may be taken for granted that one of the applications would be the supplying of current for arc lamps for the general lighting of the founding shed and the exposed places in connection with the works, and incandescent lamps for the offices, &c.

The dynamo would probably in this case be designed to give a voltage of, say, 220, and if it is capable of supplying from 160 to 1,000 amperes, it can be employed for effecting many cases of repair and remedying accidental irregularities of the furnace.

For the purposes of fusion, &c., by the electric arc, a compound-wound continuous current dynamo is the most suitable for application where a single carbon is employed, the carbon being attached to one lead by a flexible cable, and the other lead being connected to the metal to be melted.

It may be mentioned here that with this system (Benardos) of repairing by the electric current, where the fracture has caused no distortion of the surfaces, these can be brought together, lined up carefully, and a good and perfect joint made, only requiring a slight surface dressing before being put back to its working position; this is a most important consideration in numerous cases.

The usual voltage required for fusion or welding is from 50 to 80, so that rotary transformers or resistances must be employed. It is essential that the voltage should be regulated between 50 and 80 even after it has been brought down to 80, so that the operator can vary it to suit his requirements; for this purpose a special resistance frame must be employed, preferably situated within easy reach of the workman.

With the exception of the resistance frame, the arrangements are not costly. A flexible cable must be provided, and the carbon rod is connected to the end of this, with a wooden handle to enable the worker to direct the arc to the desired point.

The eyes must be protected from the brilliant light, and this can be done by placing two pieces of ruby glass with one piece of blue between, in a frame having a suitable handle, while a light tin shield protects the workman's face from the effects of the arc (in some cases this is arranged in the form of a helmet). The proportions of the carbon rod are governed by the work to be done.

In a paper lately read before the American Institute of

Mining Engineers*, Mexican meeting, Mr. F. L. Grammer describes the application of the above system to burning open the tuyeres and iron-notch of a blast furnace on occasions when, owing to some accidental occurrence, the iron has become chilled, in place of their having to be opened by the long and laborious method of hammer and drill, or the application of the kerosene blowpipe. Mr. Grammer gives an instance of burning a hole through 18 in. of cold iron in five minutes.

When a blast furnace is "blown out" there is usually found a large mass of metal, called in some localities a "bear" and in others a "horse," which must be removed before the furnace can be relined.

The usual method at one time was to rig up tuyeres, supplied with blast from the blowing engine, and to arrange coke fires at different places, thus melting grooves dividing the main lump into smaller divisions, which had to be broken off by means of wedges. To hasten and cheapen the operation dynamite has been resorted to, but this method is accompanied by much danger to life, as well as the damage to the furnace casing, &c., by shaking and by flying lumps. If the electric current is available it is a simple matter to cut up the lump by the above-described method.

Mr. H. Foster† gives an instance of the repairing of an eccentric rod of a large reversing engine by electric welding, the engine being at work the morning after the breakdown; also of the slot link of a reversing engine, in which case the engine was working again within one hour. He also gives several instances of repairs to boilers, one lead from the dynamos being connected to the boiler shell and the other to the carbon as described.

Cutting holes in iron or steel castings, plates, &c., *in situ* can readily be performed.

The instances given will readily bring to mind others in which repairs could have been carried out by means of the electric arc with rapidity and slight cost, which otherwise could only be effected by the expenditure of a considerable amount of time, involving serious loss.

REVIEWS.

Munro and Jamieson's Pocket-Book of Electrical Rules and Tables. By J. MUNRO and A. JAMIESON, M.Inst.C.E., F.R.S.E., &c. 15th Edition. London: Chas. Griffin & Co., Limited. 1901. Price 8s. 6d.

This, the best-known of all electrical table-books, is never allowed to fall far behind the times, and the present issue has been subjected to severe revision. The contract clauses approved by British cable makers have been inserted, with the table of standard sizes, resistances and weights issued by them, and the time-worn tables of resistance, &c., which have for long appeared under Messrs. W. T. Glover & Co.'s name have been replaced by an excellent set by the same firm, based upon Messrs. Clark, Forde & Taylor's 1899 determinations of temperature coefficients of copper, which are also included. The report of the Committee on Copper Conductors is, of course, inserted, and further matter on the design of dynamos and motors has been contributed by Prof. S. P. Thompson, as well as a section on India-rubber by Mr. C. Bright.

While the work is thus kept up to date in the subjects mentioned, we regret that other points have been overlooked. For example, Joule's equivalent is given on p. 17 as 772·55 foot-pounds, instead of 778, and the metric value as $4{\cdot}16 \times 10^7$ ergs, though the more correct value, 42 million, is given on p. 403. Ayrton and Mather's Universal Shunt is not clearly indicated in the index, and Price's invaluable guard wire appears to be entirely omitted, a matter for surprise in a work devoting so much space to testing.

The data regarding the increase of resistance of copper with temperature on p. 267 are at variance with practice and with Clark, Forde & Taylor's determinations, which have been adopted elsewhere in the book; and the table of specific resistances of materials on p. 270 is of very questionable value, while it is not in agreement with other data in the book. Moreover, specific resistances should never be stated in the obsolete "legal" or "B.A." units without giving the equivalent values in true ohms (see p. 279).

The "most approved" system of wiring houses and ships, illustrated on p. 286, may have been fairly good in 1894, but is precisely the same as the "older tree system," and does not appeal to us as the best. No mention of methods of vulcanising joints in position, or of the use of steel conduits for interior wiring, can be found.

The tables of permeability on p. 474 are not applicable to modern irons, while steel is ignored; abundant data are at hand for remedying this defect. Other points where excision or revision would be very desirable have met our eye, but it is impossible to refer to them all here; neither have we space to point out all the good points of what is really a remarkably complete and useful collection of rules, tables and data, well worthy of the reputation which it has acquired.

Practical Electrician's Pocket-book for 1902. Edited by H. T. CREWE, M.I.M.E. London: S. Rentell & Co., Limited (*Electricity*). Price 1s.

THE fourth annual issue of this pocket-book and diary is a revised and enlarged edition, and, as usual, is printed on good paper and in a handy form. The definitions of electrical terms have been re-written and are perfectly reliable, while a very necessary section has been made more prominent, defining the functions of electrical measuring instruments, and clearly distinguishing between, for instance, a recording watt-meter and a watt-hour meter. Evidence of extensive revision is to be found in almost every page; and this has been carried out, not on the plan too often followed by the compilers of such works—viz., by adding new matter and leaving in the old—but by the free use of the pruning-knife simultaneously with the insertion of new stuff. Further information on wiring, jointing, measuring apparatus, telephony, &c., is given, and the usual diary, memoranda pages, and perforated estimating forms are to be found at the end. For those who want, not a formula-book so much as a book of hints and condensed information, this is just the thing.

Fowler's Mechanical Engineer's Pocket-Book. 1902. Edited by W. H. FOWLER, Wh.Sc., M.Inst.C.E., &c. Manchester: Scientific Publishing Company. Price 1s. 6d.

The electrical section, which was incorporated with this work for the last two years, has now been issued separately in another form, so that the present issue is practically confined to mechanical engineering proper. As such, it merits high praise, and it will probably be almost as useful to electrical engineers as it was when the electrical section was still part of it. One of the most striking faults of electrical pocket-books, as a rule, is the poverty of their mechanical sections, for it is generally forgotten that electrical engineering is a branch of mechanical engineering, and that an electrical engineer's pocket-book should be really a mechanical engineer's pocket-book with a supplement. The best way to appreciate this is to recall one's experience in drawing-office and works—which of the numerous pocket-books available was the most frayed and worn? Not an electrical one, we feel sure.

Extensive additions have been made to the present issue, especially in the design of valves and valve gears, strength of materials, machine-tool working, gas and oil engines, &c. It contains an abundance of useful information, handy tables, &c., and is well worthy of notice.

* An abstract of this paper appeared in the *Engineering and Mining Journal*, of New York, November 9th, 1901.

† "On the Application of the Electric Arc to Machinery and Boiler Repairs, &c." *Proceedings* North-east Coast Institution of Engineers and Shipbuilders, February 12th, 1898.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

25,022. "Improved armature for (small) electric generators or motors." B. BRANDER. December 9th.

25,025. "Improvements in rods for Nernst incandescent electric lamps." L. S. POWELL and NERNST ELECTRIC LIGHT, LIMITED. December 9th.

25,076. "Improvements in insulators for high potential currents." R. GAERTNER. December 9th. (Complete.)

25,081. "An improved telephone receiver box." M. SENSENSCHMIDT. December 9th. (Complete.)

25,087. "Improvements in electric glow lamps." A. J. H. GURNEY and A. S. BLUNDELL. December 9th.

25,095. "Improvements in electrical fittings." M. CHURCHILL-SHANN. December 9th.

25,125. "Improvements in and relating to means for electrically signalling railway trains, tramcars, and the like." M. BUTT. December 10th.

25,132. "Improvements in electric switches." H. C. GOVER. December 10th.

25,136. "An arrangement whereby cork extractors and other kindred appliances can be operated by power applied electrically or mechanically." F. W. BLOWER and W. A. BAXTER. December 10th.

25,138. "Improvements in telephone switchboard cords." A. WHALLEY. December 10th.

25,143. "Improvements in or connected with telephone transmitting apparatus." M. SENSENSCHMIDT. December 10th. (Complete.)

25,146. "Improvements in switching apparatus for electric lighting, telephones, and other purposes." J. D. F. ANDREWS. December 10th.

25,155. "Improvements in the construction of induction coils and transformers." H. C. NEWTON and R. S. WRIGHT. December 10th.

25,171. "Improvements relating to electric telephone systems." G. A. CARDWELL. December 10th. (Complete.)

25,175. "Improvements in electric signalling." J. B. STRUBLE. December 10th. (Complete.)

25,182. "Improvements in electric furnaces and in the production of chemicals in such furnaces." G. BREWER. (E. R. Taylor, United States.) December 10th. (Complete.)

25,208. "Improvements relating to electric welding apparatus." H. BOSSHARD. December 10th. (Complete.)

25,215. "Improvements in telephone receivers." F. J. ORR. December 10th. (Complete.)

25,218. "Improvements in resistance coils." G. W. JOHNSON. (The Electric Controller and Supply Company, United States.) December 10th. (Complete.)

25,219. "Improvements in controlling devices for electric motors." G. W JOHNSON. (The Electric Controller and Supply Company, United States.) December 10th.

25,221. "Improvements in compounding alternate current generators and motors." A. HEYLAND. December 10th.

25,227. "Improvements in fittings for electric installations in buildings." J. MEEHAN. December 10th. (Date applied for under Patents, &c., Act, 1883, Section 103, May 16th, 1901, being date of application in United States.)

25,265. "Improvements in electric arc lamps." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (W. C. Fish, United States.) December 11th. (Complete.)

25,266. "Improvements in electric arc lamps." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (E. Thomson, United States.) December 11th. (Complete.)

25,271. "Improvements for rendering surfaces conducting in electrotyping." H. J. SHELDON. December 11th.

25,282. "Improvements in apparatus for the generation and electrolytic application of electric currents." F. E. ELMORE. (J. O. S. Elmore, India.) December 11th.

25,315. "Improvements in incandescent electric lampholders." W. DEFRIES and V. I. FEENY. December 11th.

25,318. "Improvements in electricity meters." W. E. EVANS. (The Allgemeine Elektricitäts Gesellschaft, Germany.) December 11th. (Complete.)

25,380. "New or improved method and means for attaching the carriers of electric light shades to their standards or supports." S. B. MARSHALL. December 12th.

25,384. "An electric hand lamp to give out violet and ultra violet light." L. B. MILLER. December 12th.

25,388. "Improvements in electric fuses." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (H. Geisenhoner, United States.) December 12th. (Complete.)

25,389. "Improvements in electric railways." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (F. W. Hild and S. B. Stuart, jun., United States.) December 12th. (Complete.)

25,390. "Improvements in electric rheostats." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (F. Mackintosh, United States.) December 12th. (Complete.)

25,391. "Improvements in braking systems for electric railways." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (F. E. Case, United Sta tes.) December 12th. (Complete.)

25,395. "Improvements in or relating to the manufacture of soda and other substances by the aid of electrolysis." E. GEISENBERGER. (Date applied for under Patents, &c., Act, 1883, Sec. 103, May 25th, 1901, being date of application in Belgium.) December 12th.

25,403. "Improved electric energy meter." W. P. THOMPSON. (L. Decombe France.) December 12th

25,426. "Improvements in and relating to the controlling of electric circuits." S. Z. DE FERRANTI. December 12th.

25,433. "Speed regulation devices for overhead electric carriers." H. M. HARDING. December 12th. (Complete.)

25,434. "Improved means for suspending electric lights." W. J. CHESTERTON. December 12th.

25,458. "An apparatus for converting direct or continuous current into alternating current." G. B. BATTEN. December 13th.

25,474. "Improvements in electric arc lamps." F. R. HILL and T. HAMILTON-ADAMS. December 13th.

25,490. "Improvements in and connected with electric arc lamps." T. HAMILTON-ADAMS of the firm of Wirtz & Co. December 13th.

25,491. "Improvements in and relating to electrical starting resistances." R. WAYGOOD & Co., LIMITED, and H. C. WALKER. December 13th.

25,496. "Improvements in telautographs." F. RITCHIE. December 13th. (Complete.)

25,526. "Improvements in the construction of incandescent electric lamps." H. HOGGE and E. PULSFORD. December 13th.

25,560. "Improvements in or relating to automatic controllers for electric motors." A. J. BOULT. (W. J. Richards, U.S.). December 14th. (Complete.)

25,583. "Improvements in hand-feed electric arc lamps." E. S. SHEPHERD. December 14th.

25,613. "Improvements in and relating to electrical measuring instruments." F. W. SCHNEIDER and A. STRAUSS-COLLIN. December 14th.

25,639. "Improvements in turbines, centrifugal pumps, fluid-cooled friction clutches, brakes, absorption dynamometers, and the like." H. S. H. SHAW. December 16th.

25,647. "Improvements in apparatus for controlling electric circuits." C. A. BAKER. December 16th.

25,684. "Improvements connected with renewal of electric incandescent lamps." H. E. KERSHAW. December 16th.

25,710. "Improvements in or relating to motor bicycles and electric ignition devices applicable thereto, and to motors generally." O. BAILLY. December 16th.

26,722. "Improvements in or relating to the rapid heating of water or other liquids by a current of electricity." F. H. BRIGGS. December 17th.

25,724. "A spiral sheave or trolley for use in electric overhead tramcars and the like." J. HUNT. December 17th.

25,747. "Improvements in electric fuse switch boxes." J. SACHS. December 17th. (Complete.)

25,753. "Improvements in systems of electrical distribution." J. S. PECK. (Date applied for under Patents, &c., Act, 1883, Sec. 103, May 18th, 1901, being date of application in United States.) December 17th.

25,768. "Electric fan for use in theatres and other places." H. AGHA. December 17th.

25,778. "Improvements relating to perforators for electric telegraphs." D. MURRAY. December 17th.

25,810. "Improvements in the manufacture of incandescence bodies for electric glow lamps." A. JUST. December 17th. (Complete.)

22,831. "Improvements in anchors or stays for overhead electric wires." E. A. BROWNING. December 18th.

25,832. "Improved devices applicable to the handle bars of cycles and motor vehicles and to hand barrow handles and the like." J. ROBERTSON. December 18th.

25,833. "Improvements in the method of supporting and joining the power-wire for electric tramways or railways." F. HEWER. December 18th.

25,878. "Improvements in and relating to conduits for electric and other traction cables." H. F. SPENSER and H. BRUNLEES. December 18th.

25,885. "Improvements in or relating to switches for electrical current circuits." E. F. MOY, P. H. BASTIE, and E. F. MOY, LIMITED. December 18th.

25,886. "Improvements in trolleys used in electric traction." J. HORSMAN. December 18th.

25,901. "Improvements in section insulators for the overhead construction for electric tramways or railways." W. H. LOGGEY and F. HEWER. December 19th.

25,908. "Improvements in telephones and telegraphs." W. FOXTON. December 19th.

25,909. "A method of and apparatus for localising the electric current operating tramcars and the like." J. BOOTH. December 19th.

25,941. "Improvements in tripping electric switches." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (J. D. Hilliard, jun., United States.) December 19th. (Complete.)

25,942. "Improvements in surface contact electric railways." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (W. B. Potter, United States.) December 19th. (Complete.)

25,943. "Improvements in electric railway systems." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (W. B. Potter, United States.) December 19th. (Complete.)

25,944. "Improvements in electric railways." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (S. B. Stewart, jun., United States.) December 19th. (Complete.)

25,945. "Improvements in electric railways." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (A. F. Batchelder, United States.) December 19th. (Complete.)

25,946. "Improvements in brush-holders for dynamo-electric machines." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (W. E. Baker, United States.) December 19th. (Complete.)

26,002. "Improvements in insulators for overhead equipment for electrical traction and other purposes." E. Y. WALSH and J. LEIGH. December 20th.

26,005. "Improvements in certain casings for electric wires and cables." C. J. WIGHTMAN and A. HUDSON. December 20th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1900.

2,700. "Improved method of and means for indicating speed or current frequency of electric generators." R. D. Mershon. Dated February 10th, 1900. The frequency of an alternating current is measured by the pressure indicated on a voltmeter connected to the ends of an inductance carrying the current, this being kept of a fixed strength. For this purpose, the voltmeter is connected through the secondary of a transformer to the ends of the inductive coil which is connected in series with the primary of the transformer, and a large non-inductive resistance between the conductors carrying the main current. The inductive coil has an iron core worked above saturation, while if the transformer has an iron core it must be unsaturated. The secondary is connected to reduce the pressure derived from the inductive coil. Under these conditions the transformer may be made to compensate for limited variations in the electric pressure between the conductors so that the alternating pressure applied to the voltmeter is constant unless the frequency varies, and is proportional to the frequency.

2,702. "Improved electro-magnetic brake dynamometer." E. H. Rieter. Dated February 10th, 1900. Relates to an electro-magnetic brake dynamometer. A series of magnetic poles are mounted on a ring which can make a slight rocking movement, limited by stops. Within the ring rotates, with the shaft, a heavy metal ring, and the power is estimated by the weight on an arm necessary to prevent the ring carrying the magnetic poles from moving under the induced currents. If desired, the poles may rotate and the ring be fixed.

2,703. "Process and apparatus for electrolytically treating ropes, hose, cork, asbestos, and textile fabrics of all kinds." H. W. Schiemann and A. de Castro. Dated February 10th, 1900. Any porous materials, such as waterproof mantles, sailcloth, stuffs, linen, balloon material, textile fabrics of all kinds, ropes, hose, cork, or asbestos, are passed through a trough containing a solution of any desired metallic salt, such as of copper or zinc. The material is then passed by means of feeding rolls to a table, having a metallic surface forming a cathode, which is afterwards covered by a hinged metal plate, the lower portion of which forms an anode, while the upper portion acts as a heavy lid or cover. On passing the current, the material becomes impregnated by the deposition therein or thereon of copper, nickel, iron, titanium, or other metal, and is rendered both waterproof and non-combustible. Textile material thus treated, may be suitable as roofing material, or for wearing apparel, while in the case of coloured stuffs the colours are rendered fast. The hydrogen produced during the process is blown away by compressed air fed through a tube. The lid is afterwards raised, and the material withdrawn by other rolls and fed to winding rolls. To treat hose, it is drawn over a tube laid upon the table, the anode and cathode forming lengths of half tubing.